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PERCEPTION AND TELEVISION--PHYSIOLOGICAL FACTORS OF
TELEVISION VIEWING.

BY- GUBA, EGON AND OTHERS

OHIO STATE UNIV., COLUMBUS, RESEARCH FOUNDATION

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AN EXPERIMENTAL SYSTEM WAS DEVELOPED FOR RECORDING
EYE-MOVEMENT DATA. RAW DATA WERE IN THE FORM OF MOTION
PICTURES TAKEN OF THE MONITOR OF A CLOSED LOOP TELEVISION
SYSTEM. A TELEVISION CAMERA WAS MOUNTED ON THE SUBJECTS'
FIELD OF VIEW. THE EYE MARKER APPEARED AS A SMALL SPOT OF
LIGHT AND INDICATED THE POINT IN THE VISUAL FIELD AT WHICH
THE SUBJECT HAD DIRECTED HIS GAZE. EYE-MOVEMENT DATA WERE
RECORDED FOR A SAMPLE OF 43 FIFTH-GRADERS AS THEY VIEWED A
TYPICAL EDUCATIONAL TELEVISION PRESENTATION. THE DATA WERE
ANALYZED IN TERMS OF EYE-MOVEMENT INDEXES AND GENERAL
DESCRIPTIONS. A SLOW SPEED PROJECTOR AND A FRAME-BY-FRAME
FILM VIEWER WERE USED IN THE ANALYSIS. THERE WAS A MARKED
CLUSTERING OF THE EYE MARKER ON CERTAIN AREAS OF THE VISUAL
FIELD. THE MOST DEFINITE TENDENCY WAS FOR SUBJECTS TO FOCUS
ON THE NARRATOR'S FACE. THE EYE MARKER OFTEN CHANGED IN
FOCUS. EYE MOVEMENTS DID NOT FALL INTO THE TWO CLASSIC
TYPES--FIXATIONS AND SACCADDES. RATHER, A CONTINUUM OF
MOVEMENT WAS OBSERVED. EYE MOVEMENTS TENDED TO BE LIMITED TO
A SMALL AREA WHEN THE SCENE BECAME DYNAMICALLY COMPLEX.
PATTERN DIFFERENCES RELATING TO INTELLIGENCE WERE IDENTIFIED.
IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH ARE MADE.
(JC)

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RF Project 1402
Final Report

**PERCEPTION AND TELEVISION: PHYSIOLOGICAL FACTORS
OF TELEVISION VIEWING**

Egon Guba and Willavene Wolf

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R E P O R T

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Willavene Wolf
Egon G. Guba

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CHAPTER I

STATEMENT OF THE PROBLEM

INTRODUCTION

The use of television for educational purposes has increased phenomenally over the past decade. More and more of the pupil's classroom learning is taking place through televised presentations. When television is compared with another educational medium, such as reading; however, it can be readily observed that the educator's approach to these media differs markedly. The teacher does not expect a child to pick up a book, read it, and thereby secure all of the information between the covers without any previous instruction. Instead, reading material is carefully arranged and geared to a specific level of skill. The child is given lengthy and detailed training, provided with purposeful directions and individual attention to make sure that his progress is satisfactory. In contrast, the visual aspects of television presentations are determined largely by adults familiar with the medium, but not with developmental and intellectual capacities of the child. It is rare to find a person versed in both of these areas. It is doubtful that much individual assistance or direction is given in interpreting the information funneled to the child via television. It appears that our stage of advancement in instructional television is similar to that in reading many years ago when, in a group setting, all of the children read from the same type

of book and children were expected to learn to read simply by participating orally.

One obvious reason for the qualitative difference in these approaches is the level of research in these two areas. Most of the research on instructional television has attempted only to determine its overall effectiveness in comparison with "conventional" instruction, while the research in reading has covered many facets including physiological, psychological, sociological and methodological. A great deal of basic, descriptive work in television perception remains to be done in order to lay the foundation for the more theoretical and hypothetical research which will ultimately follow. Such studies need to be undertaken in a variety of areas beginning with simple perception of the image on the television screen and ranging to complex interpretations of dynamic visual fields hinging upon personal and social factors.

It would seem reasonable to suppose that studies in the physiological realm, for example, eye movement studies, would reveal facts leading to a better approach to the design and use of educational television lessons in classrooms. An early finding of eye-movement studies in reading was that the eyes do not move in a continuous sweep from left to right across the page when a person is reading, but rather move in a series of quick, short movements and fixational pauses. This fact threw light on the way that people read and led to a revolutionary change in methods of teaching reading. Children were taught to increase their perception span, and thereby to increase their fluency and reading speed by grouping words into phrases. Devices such as the reading rate accelerator and phrased reading films were developed to "force" pupils into reading in

phrases rather than word by word.

Eye-movement studies also revealed that the type of material which the child reads and the instructions given to him greatly influence eye-movement patterns and the amount of material learned. Publishers of texts found these studies valuable in their decisions concerning the appropriate length of lines of type or, in general, the physical arrangement of the printed page.

Since these eye-movement studies in reading were so valuable in changing methods and materials in reading, it seems reasonable to suppose that similar studies of eye movements as children watch television will result in changed and improved materials and presentations in that medium. The present study was designed as a pilot vehicle to exploit that possibility.

PURPOSE

The following were objectives of the study:

- (1) developing an experimental system for the recording of eye-movement data,
- (2) recording such data for a sample of about 40 fifth-grade children,
- (3) analyzing these data to identify relevant variables and to develop hypotheses about eye-movement responses to a dynamic visual scene,
- (4) relating the identified variables and patterns to specific subject and stimulus characteristics.

With relation to the third and fourth objectives above, such questions as the following were asked: How do children's eyes move while they are watching educational television? What are the main

centers of interest when pupils look at a given scene? How much time do children spend looking at specific objects such as a demonstration item? What portions of a scene are observed by them and what portions are not observed? Are some details in a picture seemingly unnoticed while others are studied carefully? What appear to be visual distractors? To what extent are eye-movement responses influenced by the auditory aspect of a television lesson? What eye-movement indices can be identified? Are individual differences exhibited between children?

OVERVIEW OF THE EXPERIMENT

This overview is designed to give the reader a cursory understanding of the entire experiment. Prior to the study a review of the literature on eye movements was initiated. From this bibliographic survey, a summary of related research is presented in the second chapter.

An experimental system was developed for the recording of eye-movement data. Raw data were in the form of motion pictures taken of the monitor of a closed loop television system. A vidicon tube (television camera) mounted on the subject's head transmitted to the monitor an eye marker superimposed on the subject's field of view. The eye marker appeared as a small spot of light and indicated at which point in the visual field the subject had directed his gaze. This eye marker was formed by a light beam reflected from the cornea of the subject's left eye. When the eye rotated, the beam of light was reflected through a corresponding angle. An optical system focused this reflected beam and superimposed it on an image of the subject's field of view as registered by the television scene lens on his head. Thus, on the data

film records, eye responses are indicated by the movements of a small spot of light, the corneally-reflected eye marker.

Eye-movement data were recorded for a sample of children as they viewed a typical educational television presentation. The subject population was a convenience sample of forty-three fifth graders from the Columbus, Ohio, public schools. These children viewed a kinescope film consisting of a science lesson, "Health Habits," prepared for the Midwest Program on Airborne Television Instruction (somewhat edited from the original), and a segment of the NBC-produced program, "The Lively Ones," based upon the ballet music from "West Side Story." The subject viewed this film on a simulated television receiver which was actually a back-projection display housed in a television cabinet. A health knowledge pre-test was administered to the subjects a few weeks prior to the experimental sessions as part of their regular classroom routine. Immediately following the experimental run, subjects were administered several different tests designed to measure their aural and visual learning from the kinescope film. Other data about the subjects, e.g. age and intelligence, were obtained from school records. A more detailed description of the procedures is given in Chapter III.

Data analysis proceeded along two lines: a general descriptive analysis and analysis in terms of eye-movement indices. These were accomplished through the use of a slow speed projector and a frame-by-frame film viewer. The findings from these analyses, as well as the conclusions of the study, are presented in Chapter IV. A discussion of the implications of these findings and suggestions for further research are included in Chapter V.

CHAPTER II

RELATED RESEARCH

In the course of a bibliographic survey, the following major areas were investigated:

the current status of instructional television research,
the nature of eye movements,
apparatus utilized in eye-movement studies.

The following summary of related research is not intended to be exhaustive. Only those studies considered representative of the area in general or directly pertinent to this project are presented under headings of each major area.

INSTRUCTIONAL TELEVISION RESEARCH

Instructional television research seems to fall into three categories with the preponderance of studies in the first category, fewer in the second, and very few indeed in the third category.

Educational Television in Comparison with Other Educational Media

Considerable research has been conducted to determine the overall effectiveness of instructional television. Some studies report a significant superiority of televised instruction, not only over classroom lecture (Tannenbaum, 1956; Boone, 1954; Rock, Duva, and Murray, as reported in Kumata, 1956) but also over other teaching means, such as,

radio and reading (Williams, 1954). In general, the findings have been that television instruction can be as effective as regular classroom teaching (Anderson and VanderMeer, 1954; Carpenter and Greenhill, 1955; Driscoll, 1957; Evans et al, 1955; Greenhill et al, 1956; Hasen, 1952; Herminghaus, 1957; Husband, 1954).

Different Types of Television Presentations

The relative effectiveness of different general types of instructional television presentations have been evaluated. Brandon (1956) compared the effectiveness of lecture, interview and discussion techniques while Jorgensen (1956) compared three methods of television newscasting (newscaster alone, newscaster using still pictures, and newscaster using motion pictures). Ulrich (1955) using eighth graders found a significant difference on an immediate post-test but not on the delayed post-test comparing straight lecture to lecture with visual aids. In general, the investigators found no significant differences in the amount of information learned as a function of the method of television presentation; although, there were differences in audience preferences and interest.

Influence on Learning of Television Presentation Variables

Rock, Duva, and Murray (as reported by Kumata, 1956) reporting drama to be the least effective means of presentation concluded that the amount of learning is directly related to the explicitness of the treatment of information. Freeman and Neidt (1959) found that the amount of learning is not dependent on whether background music is familiar or unfamiliar. Although, Jorgensen (1956) reports that information in the final third of the program was learned best, middle third next best,

and initial one-third least; Vernon (1953) found that important statements and generalizations were less likely to be remembered if they occurred near the end of the program. Conclusions and findings from different studies in this area are many times inconclusive or contradictory.

Although these studies have been informative in the general sense, there have been few attempts to up-grade television instruction by experimentation. The response of the learner to specific stimulus material used in telelessons has not been investigated. It was for this reason that the present eye-movement study was undertaken.

THE NATURE OF EYE MOVEMENTS

On the basis of accepted terminology from previous studies dealing with eye movements, certain indices, such as, fixation frequency, fixation duration, inter-fixation distance, etc., were expected to be useful in classifying and quantifying the data of this project. However, as will be reported later, the eye-movement behavior of this investigation did not fall into the generally accepted categories of response previously cited. Therefore, it is necessary to review the literature on eye movements from a phenomenological point of view so that the difference in the findings between previous studies and this study will be understood. Although many studies are termed eye-movement studies, they are basically concerned with what is considered to be the most important aspect of eye behavior: fixation. Eye movements are thought to serve either in maintaining or changing the fixation without disturbing a person's continued coherence of the visual world. This section will present general conclusions from specific investigators in the field as to the

nature of certain kinds of eye movements and information pertinent to the data of this study. The following discussion has been divided into these topics: fixation, physiological nystagmus, saccades, pursuit movement, and patterns and tasks.

Fixation

The eyes are said to be in motion always and their movement consists primarily of rapid sweeps with brief pauses or fixations (Cobb and Moss, 1962). Fixation is not absolute and precise. Riggs and Ratliff (1951) found that the eyes are never similarly stimulated by a single point in the visual field; that instantaneous separation of two "corresponding" retinal points deviate widely to a median extent of 10 to 20 seconds of visual arc. The eye's center of clear vision (the fovea) is not a mathematical point, but rather an area of $1/3$ degree surrounded by an area of 2 to 3 degrees of decreasingly clear vision (Riggs, 1964).

It is generally held that an impression adequate for perception occurs only during the fixational pause when the image is nearly at rest upon the retina. Yarbus (1954) reported fixational pauses of .2 to .5 seconds as the most frequently observed when subjects freely surveyed non-moving objects; with no fixation shorter than .05 seconds or longer than 2 seconds. For people looking at pictures, Buswell (1935) found a distribution of fixational pauses varying from .065 to 2.7 seconds with a mean of .32 seconds and a mode of .23 seconds. Tinker (1938) obtained an average fixational pause of .157 seconds to be required to identify a letter after an eye movement of 12 degrees while Luckiesh (1931) found

the shortest time possible to see an object varied from .07 to .30 seconds, the difference in time reportedly due to difference in intensity of illumination which a subject requires for stimulation (Saltzman and Garner, 1948).

Physiological Nystagmus

Several experimenters have investigated the exceedingly small eye movements which occur when the eyes are fixated, classifying these eye movements as micro-movements or physiological nystagmus. Cornsweet (1956) reported that when a subject tried to fixate a point, the eyes were in constant involuntary motions which he categorized as: tremors, slow waves, slow drifts, and rapid flicks. All of these movements are less than one-half degree of visual arc, and in both monocular and binocular fixation these movements of the eyes are coordinated (Ditchburn and Ginsberg, 1953; Higgins and Stultz, 1953). Reinecke (1961) however, has described electro-oculogram records indicating a great number of small disjunctive movements.

The general consensus is that retinal receptors will tend to lose their response capacity if continuously stimulated without variation. Hence, minute eye movements aid in preserving continuous vision by presenting fresh unfired retinal receptors. However, Keesey (1960) found that physiological nystagmus neither enhances nor impairs visual acuity; and Nachimas (1960) reported that it does not contribute to meridional variations in the visibility of visual detail. In an attempt to determine the extent and duration of physiological nystagmus, Easton (1957) using a photo-electrical method observed: (1) flicks ranging from 3 to 30

minutes of arc lasting no more than .03 seconds appeared at intermittent intervals, (2) slow waves and drifts of 5 to 20 minutes of arc of approximately 1 second duration sometimes appeared between flicks, (3) waves up to 15 minutes of arc varying between .2 and .1 seconds.

In a dozen healthy males between the ages of 20 and 30 Hebbard (1960) delineated three kinds of physiological nystagmus:

- (1) Tremor or micronystagmus with extent of 10 to 14 seconds of visual arc and a mean frequency of 85 cps.
- (2) Flicks or jerks with an extent of 5 to 6 minutes of visual arc and a mean frequency of 1 to 2 cps. (sometimes these are also referred to as saccades, but their extent is so restricted that typical apparatus used in eye-movement studies would be unable to detect them).
- (3) Slow drifts or waves (the combined extent of a drift with tremor and a flick might be as high as 12 minutes of visual arc).

Saccades

A saccade is the large or small sweeping movement of the eyes of very brief duration (relatively high velocity) as the eyes move from one fixation to another fixation. Westheimer (1954b) found saccadic movements to have a high degree of simultaneity of onset of the movement in the two eyes, a rapid acceleration to a maximum velocity which is non-linear, and a significant overshoot and minute oscillations around the final position. He further concluded that saccadic movement is initiated as a single unitary step by means of simultaneous changes in innervation to each of the eye muscles involved. Krauskopf, Cornsweet and Riggs (1960) showed that saccades are almost always conjugate (identical in both eyes) and that their magnitudes are highly correlated. Von Tschernack-Seysenegg (1952) states that under ordinary conditions the extent of eye movement hardly

exceeds 18 degrees, beyond which movements of the head soon come into play.

A source of debate in the past had to do with whether there is vision during eye movements. In contrast to Holt's position in 1905 (Tinker, 1936), Bell and Weir (1947, 1949) brought out that the retina is stimulated during saccades and hence there is some vision, but blurring is so extreme and saccades so very brief that usually not even a blurred impression is received. Volkman (1962) recently found that detection thresholds for dot patterns and recognition thresholds for words do exist but are considerably higher during saccades than during steady fixation. He concludes that vision is significantly depressed during eye movements and postulates some central inhibitory mechanism.

A second source of recent debate concerns the theoretical function of eye movements in perception and learning. Zinchenko (1958) supports a dynamic theory stating:

Object imagery through tactile perception is impossible unless the hand moves over the object and picks out some of its component parts. In visual perception eye movements may play a similar role. In static theory visual images are thought to be formed in the mind like momentary photographs the instant the object is caught by the eye. Here the role of eye movements is reduced to focusing the object and replacing some fatigued portions of the retina by others if the process of seeing is prolonged. In dynamic theory, on the other hand, no constant image is formed in the mind simultaneously with presentation of the object, but various components of the latter keep being continually spotted by the moving eye.

However, Mooney (1958, 1959) reported a series of experiments designed to compare the single glance to successive scanning in the recognition of novel configurations and concluded that his findings did not warrant the conclusion that visual inspection possesses any real advantage over the single, brief glance in learning novel configuration stimuli.

The time taken to move the eyes between fixations is relatively short and varies with the stimulus material. Quick movements to the right made in reading cover from 1 to 4 degrees and take about .01 to .02 seconds; longer return sweeps to the beginning of the next line (15 to 21 degrees) usually require .04 to .045 seconds (Fitts, 1951). Tinker (1951) reported that movement time in reading constitutes from 5 to 10 per cent of the total time with a mean of 7 per cent. Yarbus (1954) reports that in the process of freely surveying non-moving objects the eyes are in a state of fixation for about 97 per cent of the time and in saccadic movement for only 3 per cent of the time. The duration of a saccade depends upon the distance traveled, the duration of a horizontal saccade between two points subtending an angle of 20 to 30 minutes is .01 seconds; for an angle of 20 degrees, it is .07 seconds. So too, the maximum angular velocity of the eye during a saccade depends on the visual angle between the fixation points. For an angle of 1 degree it is close to 80 degrees per second; for an angle of 20 degrees it is 400 degrees per second.

Gerathewohl and Strughold (1954) present data which indicate that the duration of eye movements depends upon the direction of the motion; that there is no practical difference in the angular velocity if the eye movements are under 10 degrees, but differences in time consumption increase when the eye has to cover a larger angular extension.

Pursuit Movement

In looking at a moving object the eyes tend to follow it, or rather, keep pace with it. Depending upon the speed and the constancy of the velocity of the moving object, the eye can stay right on it, with a tendency

to fall behind it and catch up again by a saccade as the speed of the object increases (Westheimer, 1954a). Dodge, Travis, and Fox (1930) state that satisfactory pursuit may be achieved as long as the angular velocity involved is below about 40 degrees per second. Pursuit and saccadic movements are held to have quite different characteristics in that pursuit movements are generally very smooth and involve relatively slow changes in position while saccadic movements are very rapid and show defined changes in velocity during their course. When a large moving object presents interesting details, the eyes make saccadic movement from one part to another as they do with a stationary object, but each fixation consists in a pursuit movement. Contrary to the previously held general belief that pursuit movements cannot be executed except in the presence of a moving stimulus, Westheimer and Conover (1954) demonstrated that smooth, slow movements of the eye can occur under conditions other than those involving a moving object.

Patterns and Tasks

Fry and Enoch (1957a, 1957b, 1957c) and Enoch (1960) using three trained photointerpreters viewing aerial photographs found that the search pattern was divided into two phases: (1) an orientation or basic search phase in which the observer moves his eyes in a characteristic pattern which is highly individualistic, (2) a specific search phase which depended upon the observers finding some clues to utilize in target location during the orientation phase.

Buswell (1935) also found two general types of eye-movement patterns in response to looking at static pictures and designs: (1) a general survey in which the eyes move with a series of relatively short pauses over a main

portion of the picture, (2) a second type (not always manifested) consisting of a series of fixations usually longer in duration concentrated over a smaller portion of the field evidencing detailed examination of those sections. The general survey phase usually characterized the early part of an examination of a picture; the more detailed study usually appeared later, if at all. Buswell's data also indicate wide individual differences in both patterns and durations of fixations; fixation duration seems to increase as one continues to look at a picture, possibly indicating a mental process of reflection. Buswell also found that the pattern of eye movements does not resemble the general pattern of design of the picture, and that if a human is depicted it usually receives a great deal of attention particularly on the face and hands. Comparison of a set of records of a small group of sixth graders with those of adult subjects showed no consistent differences and no evidence of a learning to look at pictures equivalent to learning to read.

Although Dallenbach (1923) and Brandt (1940, 1941) found diametrically opposed areas to be preferred positions, Hackman and Guilford (1936) also using advertisements found that the average looking time was about the same on right and left halves of the visual field. Bartley (1959) concluded that with simple target material, there were no position preferences. One of Brandt's experiments to evaluate position preferences required that subjects learn patterns in various positions of the visual field so that they could later reproduce these patterns. Brandt suggested that conditions which influence and determine the character of ocular patterns in learning are:

- (1) intellectual capacity of the individual,
- (2) character of the field observed,

- (3) the nature of the task,
- (4) past experience of the learner,
- (5) purpose of the learner at the time of the observation.

Gerathewohl (1952) recorded the eye movements of 5 subjects viewing radar which simulated orientation, navigation, target identification and bombing tasks. As the nature of the tasks changed in the above sequence, Gerathewohl found fewer fixations per second with longer durations. Gerathewohl, Strughold, and Taylor (1956, 1957) analyzed the pattern of guided eye movements with regard to form and speed. They found that as the rotational speed of a sweep line around a radar scope increases, the movement of the eye became more frequent and intensive.

White and Ford (1960) under conditions of free search of a static, empty circular field subtending 30 degrees of visual angle found the average number of fixations per second to be 3.1; the mean duration of fixations to be .28 seconds; and the mean extent of saccadic movement to be 8.6 degrees with a mode about 4 degrees. In a typical example of one subject's responses there appear quite a few eye movements of a non-saccadic nature. In a second part of their study where both a 30 and 15 degree visual field was used with an internal dynamic feature--a radar sweep line making one revolution in about eight seconds--the authors found that search activity differed greatly from that in the first part of the study. Rate and duration of fixations became meaningless measures because "The eyes tended to track the sweep line, making occasional saccadic movements in and out along that line."

From the previous studies it can be observed that eye behavior has been generally classified as being either fixational (including physiological nystagmic movements) or saccadic with the exception of pursuit responses to

a particular moving stimulus. In the present study, these concepts were not adequate to describe the eye-movement responses of the subjects to a dynamic bi-dimensional field.

APPARATUS UTILIZED IN EYE-MOVEMENT STUDIES

Early Investigations

Development of techniques to obtain eye-movement data began in the middle of the 19th century. Unique methods were used by experimenters in their first attempts to observe the eyes and how they move (Woodworth, 1938). Both Helmholtz and Lamasky utilized an after-image method, whereby the eye remained fixated on a bright spot of light for a period of time after which the experimenter observed his own eye movements as the after image shifted along a line of print. Later, some experimenters such as Javal directly observed the subject's eyes while he read. Two later and spectacular attempts to record eye movements were made by Delabarre (1898) and Huey (1908). They anaesthetized an eye of a subject and mounted on the eye a ring of plaster of paris in which was inserted a wire. This wire was connected to a writing lever which recorded movement on a steadily revolving smoked drum. Miles (1928) devised a "peephole" technique by cutting a hole into a page of print hoping thereby to observe without distracting. While crude in design, these early studies gave some indications of how the eyes move. For example, Javal reported that the eyes do not move in a continuous line when the subject is reading but instead move in a series of sharp jumps which he termed saccades.

Electro-Oculographic Techniques

A more recent and much more sophisticated technique was used by Hoffman (1946), Lion and Brockhurst (1951), and further elaborated by Shackle, Sloan, and Warr (1958). This method, referred to as the EOG or electro-oculographic technique (Shackle, 1960; Ford, White and Lichtenstein, 1959; Crossman, 1961) takes advantage of the fact that electrical potential differences exist between the back and front of the eye. Electrodes are placed above and below and at the temporal side of each eye. As the cornea approaches or recedes from an electrode, the electric field at the site of that electrode varies accordingly. By means of appropriate amplification and recording it is possible to obtain records of the horizontal and vertical components of eye movements. This technique, while moderately reliable in measuring small eye movements for short periods of time, does not lend itself well to studies in which the relationship of the eye movements to a television lesson is the primary concern. This is largely due to the fact that the potentials measured by the electrodes are greatly influenced by other potentials due to effects similar to those measured in galvanic skin response (GSR) studies. These extraneous potentials are not a function of eye movements and therefore introduce very large errors in the data unless periodically corrected.

Photo-Electrical Technique

Smith and Warter (1960) describe a new photo-electric technique in which an image of a small portion of the eye at the limbus (the juncture of the iris and sclera) is cast upon a surface containing a small slit behind which is located the photocathode of a photomultiplier tube. As

the eye rotates more or less total light is reflected into the photo-sensitive element of the tube which can subsequently be related directly to the angular position of the eye.

Corneal Reflection Techniques

An early technique of proven experimental productivity and upon which the methodology of the present study is based is the corneal reflection technique first reported by Dodge and Cline (1901). In this technique the front surface of the eye is used to reflect a beam of light from a fixed source so that as the eye rotates this beam of light is reflected through a corresponding angle. With this method, fairly accurate information about eye movements may be obtained, and the relationship of the eye movements to a visual field may be studied.

Cameras utilizing the corneal reflection technique were used in many of the eye-movement studies in the area of reading. These cameras were monodimensional in that they recorded only in the horizontal dimension. Subject's heads were usually rigidly restrained to avoid error introduced by head movements in the placement of the eye marker on the appropriate portion of the stimulus field. Investigators who wished to study bi-dimensional space needed to add the vertical range and found many problems in the available apparatus. Some of these investigators include Buswell (1935) who studied eye performance of subjects while they looked at pictures, Brandt (1940, 1941) who studied eye movements while subjects viewed a pattern, and Wendt (1952) who studied subjects' eye movements while they viewed motion pictures. Buswell found it necessary to record the horizontal and vertical movements separately and then plot them manually onto the stimulus field

which had been presented to the subject. He used a recording camera with two films which moved continuously during the process of photographing and then made his analysis by computation. A second lens on the apparatus recorded head movements. Brandt, in order to overcome the problem of using two films to record vertical and horizontal movements, developed a monofilm camera which produced a single film photographing simultaneously both the horizontal and vertical movements of the eyes. This camera reduced the amount of film required by half and minimized the labor involved in handling and developing two separate records but still required the manual superposition of the fixation marker on the stimulus field.

A major difficulty was encountered by Wendt because he studied subjects' eye movements related to a moving field. Wendt adapted the Brandt camera and was able to superimpose a fixation marker on a motion picture screen but was unable to photograph faster than 6 frames per second although the stimulus field was projected at 24 frames per second. This increased the labor in data analysis. Although this apparatus required the head of the subject to be rigidly restrained, there were head movements which necessitated additional plotting so that necessary corrections could be made.

Mackworth (1958) using one television camera to pick up a corneal reflection from a fixed head and another TV camera to record the subject's visual scene, succeeded by electronic mixing in placing an eye marker on a reproduction of the visual scene. Later, this technique was improved to permit more or less free head movements by mounting a small motion picture camera on the subject's head (Mackworth, Llewellyn-Thomas, and Holmquist, 1960; Mackworth and Llewellyn-Thomas, 1962).

Mackworth's technique was utilized in this study because it has certain

advantages over other apparatus. These advantages are as follows:

- (1) The apparatus does not require rigid restraint of the subject's head.
- (2) Fairly accurate alignment can be achieved with relatively good reliability over extended experimental sessions.
- (3) The eye marker can be directly superimposed over the visual scene permitting direct observation at the moment of response and later by means of data films. This eliminates the absolute necessity of measurements and computational manipulation to achieve correct placement of the eye marker on the visual field.

CHAPTER III

PROCEDURES

APPARATUS

The experimental apparatus system developed for this research consists of six major components: (1) a projector for the presentation of the stimulus materials; (2) a simulated television set for the display of the stimulus materials; (3) a helmet-mounted corneal reflection system and television camera to obtain eye-movement data; (4) electronic controls for the helmet-mounted television camera; (5) a television monitor for the display of the eye-movement data; and (6) a motion picture camera to record the eye-movement data from the television monitor. A schema of the system is illustrated in Figure 1.

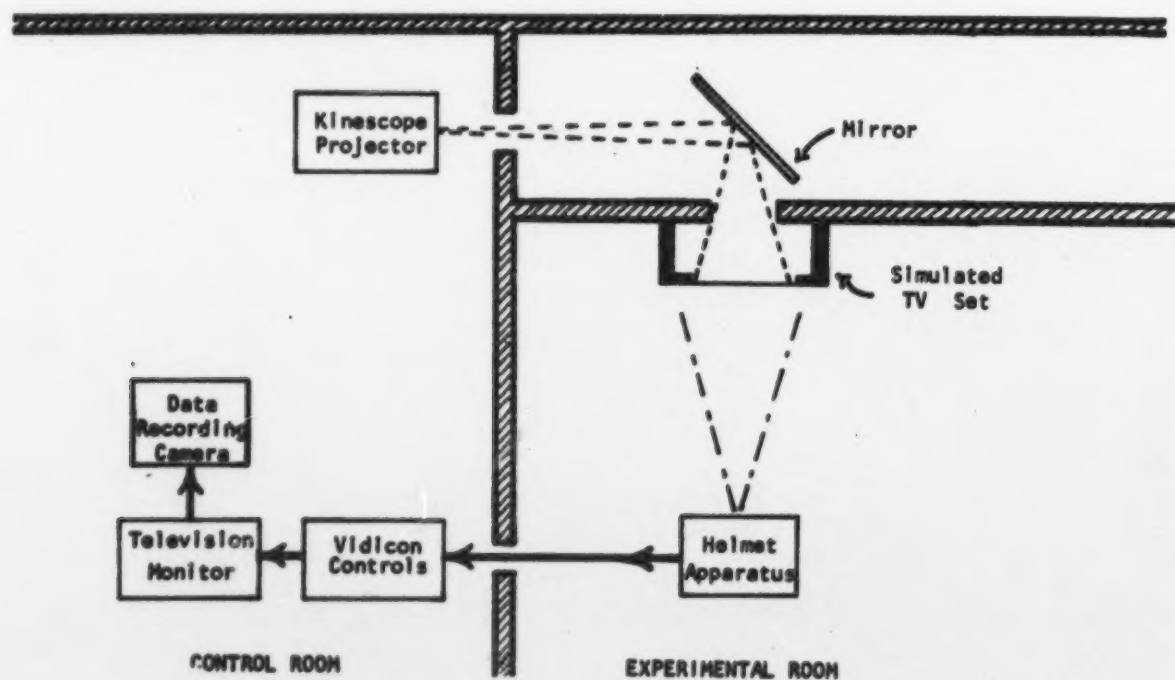


Figure 1: Schema of System

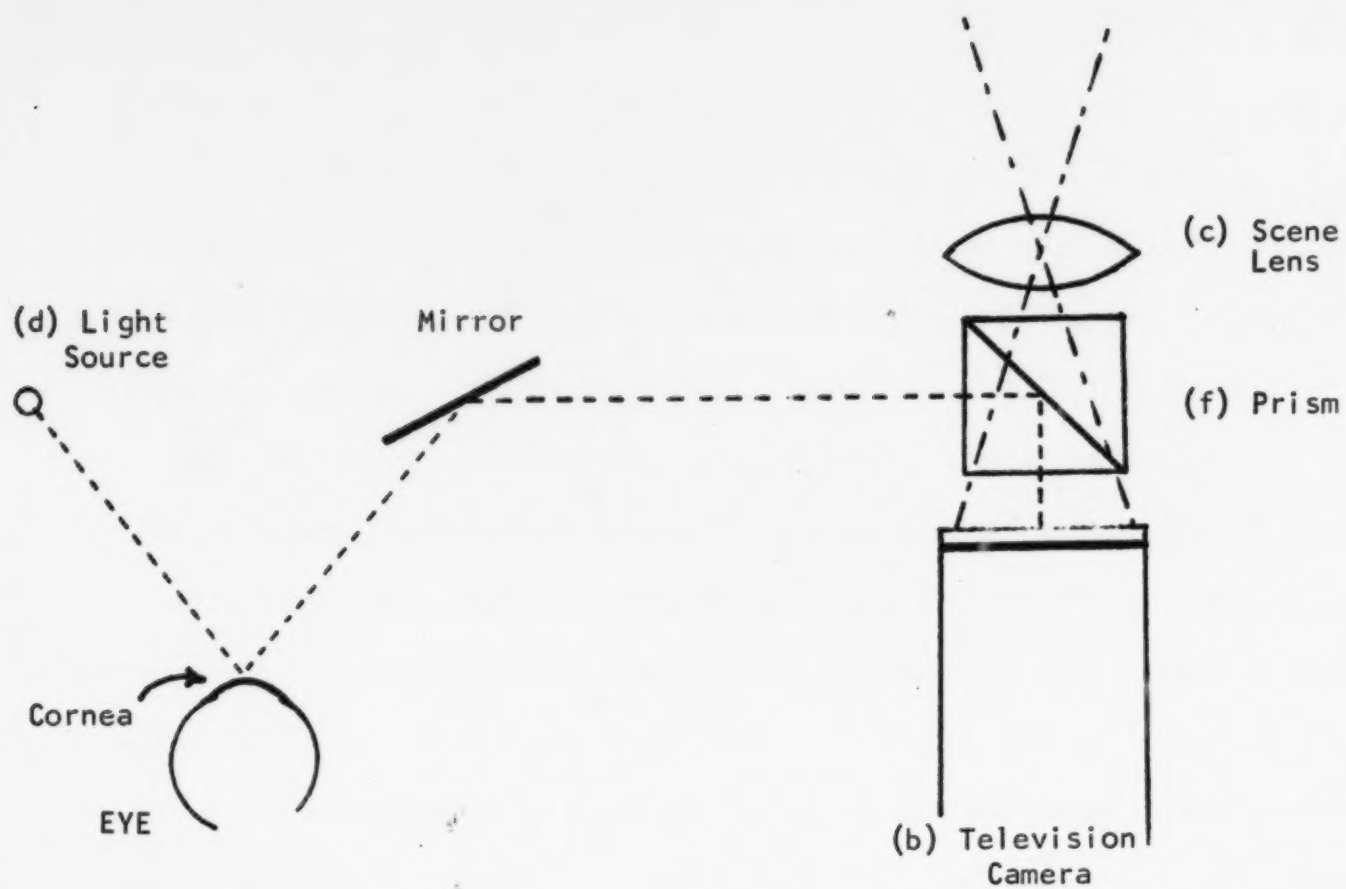
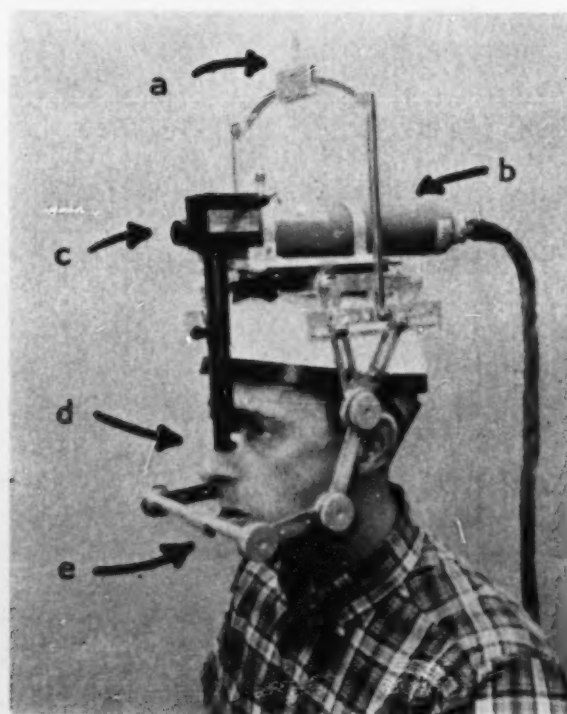


Figure 2: Principle of Operation of the Helmet Apparatus



- (a) Counterbalance Suspension
- (b) Television Camera
- (c) Scene Lens
- (d) Light Source
- (e) Bite-Bar

Figure 3: Helmet Apparatus

Figure 2 illustrates the basic principle of the corneal reflection technique used to obtain eye-movement data: the helmet apparatus is shown in Figure 3. Light from a miniature filament bulb (d--near the bottom of the vertical tube) is reflected by the corneal surface of the eye. The tube serves simply to transmit the reflected light beam to the optical system on top of the helmet. As the eye rotates, this light is rotated through a corresponding angle, indicating the eye movement; this corneal-reflection beam forms the so-called eye marker. The double prism (f) functioning as a half-silvered mirror effects the superimposition of the eye marker on an image of the visual field obtained by the scene lens (c), located near the front of the small television camera (b). This small transistorized television camera (developed by Dumont Laboratories) is mounted as an integral unit together with the corneal reflection light source, the scene lens, and associated optics. Provisions have been made on the helmet for initial and subsequent adjustments to focus and reference the eye marker, and to aim the television camera properly at the visual field. In addition to being counterbalanced (a) so as to seem relatively weightless, the apparatus is also somewhat balanced about the axes of head movements. The bite-bar system (e), stabilizing the helmet on the head, has provisions for the attachment of individual mouth pieces fitted for each subject with a dental impression compound. With this system of counterbalancing and stabilizing, the apparatus is comfortable and relatively non-restrictive of normal head and body movements for a seated subject.

The eye-movement data obtained with the helmet apparatus was displayed on the television monitor shown in Figure 4. The image of the total visual field appearing on this monitor covers an area of approximately 20 by 30 degrees of arc, while the stimulus field (the simulated TV screen) covers approximately 12 by 16 degrees.* The eye marker, indicating where in this field the subject is looking at any instant, appears as a bright spot which is typically one degree in diameter. That the eye-movement data is immediately observable on the monitor is one of the significant features of this apparatus. This monitor, and the 16mm motion picture camera, which made a permanent record of the data, were also located in the Control Room.

The stimulus materials were displayed for the subject on the simulated television set by a rear-projection method. A convincing simulation



Figure 4: Monitor, Controls, and Motion Picture Camera

*The maximum dimensions of the simulated television screen were 13 by 17 inches and this screen was placed approximately 62 inches in front of the subject.

of a television display was achieved by using a television cabinet from which the chassis had been removed, and replacing the original picture tube by a ground glass screen (Figure 5). The controls on this simulated television set also operated the stimulus materials projector, which was located in an adjoining Control Room.



Figure 5: Simulated Television Set

STIMULUS MATERIALS

The Television Lesson

After reviewing and evaluating instructional television materials at the National Educational Television Film Library at Indiana University, selected Midwest Program on Airborne Television Instruction (MPATI) programs at Purdue University, and materials at The Ohio State University, the project staff selected a telecast, "Health Habits" from the MPATI Adventure of

Science series, as stimulus material for the study. This program is considered representative of the type and quality of instructional telecasts intended for the middle elementary grades. To facilitate the review of large amounts of material during the selection process, an objective rating form was developed (see Appendix A). The completed rating forms were accompanied by supplementary commentaries from each reviewer.

Because of the limited film capacity of the motion-picture camera which was used to record data, three minutes of material were edited from the original twenty-minute lesson. A complete description of the edited lesson is given in the scenario in Appendix B.

Actual recording of data was begun with Scene 8, approximately four minutes after the beginning of the edited lesson. During the 13.3 minutes of the lesson which were recorded, the narrator appears on the screen 61% of the time. The visual material of the other 39% during which the narrator does not appear may be categorized as follows: film clips of blood cells and bacteria (16.6%); still photos and sketches (17.8%); film clip of body exercises (2.1%); and a panning shot (2.5%).

A kinescope film was used for stimulus material, preserving the scanning lines of television. In order to enhance further the effect of an actual television presentation, a brief segment of "flip-flop" material, typical of a television image when the set is first turned on, was spliced to the beginning of the lesson.

West Side Story Sequence

Following the television lesson was a brief segment from a commercial telecast. This sequence was selected for exploratory purposes because its

abstract, affective character was in direct contrast to the preceding lesson. The auditory track of this segment consisted of music from "West Side Story," while the visual scene was a fast-moving series of animated patterns and illustrations synchronized with the sound.

Supplementary Stimulus Material

Referencing triangles and the standard fixation panel were two additional visual stimuli used during the experimental sessions. Their purpose was to aid in the observation, correction, and recording of error in the eye-marker data.

The referencing triangles were ten-second sequences of film which consisted of a small white triangle on a black field inserted in the television lesson. Five such sequences were inserted at points where they would not disrupt the continuity of the lesson. When the subject fixated this triangle, any error in the position of the eye marker could be observed. Any necessary corrections could then be made, using this triangle as a reference point. Information as to both the existing error at the beginning of each referencing triangle sequence and the correction made by the end of this sequence were recorded by the motion picture camera and became part of the permanent data record film.

The standard fixation panel in Figure 6 served in the measurement of another type of error. When the subject had fixated a point in the center of the visual field and the helmet apparatus had been adjusted to superimpose the eye-marker image on this point, there might have been errors in the position of the eye marker when the subject then fixated other points in his visual field. This type of error has been termed spatial error.

In order to measure and record this error the standard fixation panel, on which were mounted eleven miniature light bulbs, was placed over the screen of the simulated television set. The central bulb was switched on and as the subject fixated this light, referencing adjustments were made in the helmet apparatus to superimpose the eye-marker image on the image of the point being fixated. Once this had been achieved the experimenter switched on each of the other panel lights in turn. As the subject fixated each of these points, the error in the placement of the eye marker was recorded by the data recording camera and became a part of the permanent data film.

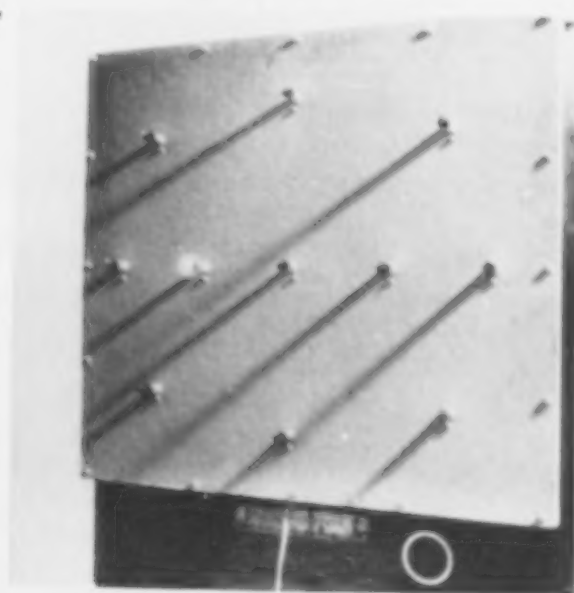


Figure 6: Standard Fixation Panel

SUBJECT SAMPLE

Seventy-four children from four fifth grade classes in two schools were selected as subjects for the experiment. Each candidate was subjected

to physical examinations by his school nurse to determine fitness for the procedures involved. Minimal criteria were: 20-30 vision or better; approximately normal hearing; and fair dental condition, necessitated by the bite-bar on the helmet apparatus. Certain children were eliminated for failure to meet these criteria, and others became unavailable for the experimental sessions. Data were finally collected on a total of 21 boys and 22 girls.

CRITERION DATA

Criterion data of three major types were used: scholastic aptitude scores, content pre-test scores, and content post-test scores.

Scholastic Aptitude

The California Test of Mental Maturity (Short Form, 1957 revision) had been administered by the home room teachers less than two months before the start of the experiment. The following scores were made available to the Television Perception Project:

- (a) overall mental age and intelligence quotient,
- (b) non-language mental age and intelligence quotient,
- (c) language mental age and intelligence quotient.

In addition, four sub-test scores were obtained from each child and converted to percentile ranks from tables presented with the CTMM manual for the age groups into which the child fell. These sub-test scores were:

- (a) spatial relationships,
- (b) logical reasoning,
- (c) numerical reasoning,
- (d) language.

Pre-Test

As a pre-test, an Ohio Every Pupil Test (Elementary Science and Health for Grades 4, 5, and 6; First Semester 1960-61 edition) was administered by the home room teacher as though it were part of the regular testing program of the school. Thus a health knowledge score was obtained for each student without sensitizing him to the purposes of the study.

Post-Test

An instrument for measuring pupil learning was developed from the scenario based upon a typescript and scene analysis of the television lesson. Since the telelesson simultaneously presented both visual and auditory learning material, an attempt was made to evaluate visual learning and auditory learning separately. The content of the instrument was guided by the general assumption that some pupils are video dependent, that is, they learn more from visual stimuli than from audible commentary; and, conversely, that some pupils may be audio dependent. Administration of the test was by interview with the same experienced tester throughout. The entire session was tape recorded by means of a hidden microphone. This test consisted of three sub-tests which attempted to:

- (a) assess differential learning from the visual portion of the telelesson and its audio commentary,
- (b) measure general information acquired from the film,
- (c) measure ability to recall and correctly identify objects from test items consisting of limited visual cues,
- (d) measure information acquired and attitude toward the West Side Story sequence.

In view of the fact that these tests proved not to be useful, no more will

be said about them here. The interested reader is referred to Appendix C for further details.

EXPERIMENTAL SESSIONS

The experimental sessions proceeded in several steps.

- (1) A log entry was made of the subject's name, address, birthdate, sex, school and room number, right and left eye Snellen acuity, and performance on a screening color-blindness test. Each subject was assigned an experimental number.

- (2) The following explanation was then given:

We are interested in studying television, especially the kind of television shown in schools. You will be watching an educational television lesson. We are studying what you see and to find this out we will take a picture of your eye. Naturally, this is a very difficult thing to do, and in order to do it, you will be wearing a special helmet with a special camera on top of it. Here is a picture of a boy wearing the helmet we use in this experiment. The camera sees your eye through this little tube called a periscope. You notice that the boy in the picture has something in his mouth. It is called a bite bar, and that bite bar was made especially for him like the one I am making just for you. The reason you need a bite bar is so that the camera on the helmet doesn't jiggle around.

- (3) Metal bite bars had been made in advance. For each subject, a bite bar was covered with a dental compound, heated to the proper temperature and then inserted in the subject's mouth. After the compound had cooled, the bite bar was trimmed with a knife to eliminate any excess wax.
- (4) Another experimenter acquainted the child with the apparatus. He was shown the television set, allowed to handle the helmet and sit in the experimental chair with the helmet on his head.
- (5) The bite bar was then attached to the helmet and the helmet fitted to him.
- (6) The standard fixation panel was placed over the front of

the simulated TV set and the corneal reflection marker focused and calibrated to the central light on the panel. In order to focus the marker properly, the experimenter received instructions via the intercommunication system from the controller who had full view of the observation and recording monitor. When the eye marker was referenced and focused, the following instructions were read to the subject:

Now we are going to take pictures of your eyes while you look at different lights. But first, before we take the pictures, we will run through what you are going to do. Whichever light comes on, look directly at it until I turn it off and another one on. Then look at the next light which is on. We will do each one of the lights that way. When we are finished, I will say "O.K., relax." Let's try it out before we start. You are looking at the center light--that is good. Now comes this one (Experimenter turned switch until all lights had been presented). All right, let's do it again for the camera.

- (7) Next, the standard fixation panel was removed from the television set and the experimenter made the following statement:

Now we are ready for the television lesson. We are on closed-loop TV which means that this lesson is being sent from a place right here on the University campus. We have asked the TV station to interrupt the lesson five times so that we can photograph your eye. While we are taking that picture, you will see a little triangle right in the middle of the TV screen for 10 seconds. We want you to look right at that triangle. When the triangle is gone, and for the rest of the time, we want you to watch the program just like you would a TV program your class was watching at school. We want you to relax and enjoy it, but pay attention to it too.

- (8) The experimenter then turned on the simulated TV set which automatically started the projector in the control room, extinguished the room light and sat near the subject in order to make any adjustments suggested by the experimenter in the control room.
- (9) Two persons, one to observe and the other to make suggestions to the experimenter, and start the

recording camera, remained in the control room throughout the entire session. Recording of data with the motion picture camera was begun with Scene 8 of the telelesson, four minutes after the beginning of the film. Data recording was terminated a few minutes after the onset of the 'West Side Story' sequence which was appended to the lesson.

- (10) After the telelesson, the tester established rapport with the child and then gave him the post-test.

The entire experimental session from the time the child left the school until he was returned averaged two hours.

CHAPTER IV

RESULTS AND CONCLUSIONS

INTRODUCTION

Extraction of data from record films presented an appreciable problem in itself since a total of more than 650,000 film record frames needed to be considered for analysis. A survey of the data films was first performed through repeated viewings with a variable speed motion picture projector. In this exploratory phase an attempt was made to formulate worthwhile approaches to analysis and to select scenes from the stimulus material that merited special attention.

The data film for each experimental session represents approximately 18 minutes of recording time. Each data film contains:

- (1) the subject number which had been assigned serially for each experimental session;
- (2) eye-movement responses to the television lesson, 13.5 minutes;
- (3) eye-movement responses to the appended "West Side Story" sequence, approximately 2 minutes; and
- (4) responses to the standard fixation panel and referencing triangle, giving an estimate of error.

Also included in each data film are referencing indicator and time indicator information. The referencing indicator was a small light mounted at the upper right corner of the monitor from which data were recorded. This indicator was switched on by the experimenter in the experimental

room whenever it became necessary for him to make adjustments of the helmet apparatus at times other than the regular triangle referencing points. This referencing index made it possible to eliminate those sections of the eye-movement data which were contaminated by experimenter manipulation. The time indicator was located in the upper left corner of the monitor. This indicator flashed every six seconds and was intended to serve as an objective measure of time when the data film was projected with a variable speed motion picture projector. Examples of data film frames are given in Figure 7 and Figure 8.



Figure 7: Example of Data Film Frame



Figure 8: Example of Data Film Frame

Types of Data Analysis Performed

Subsequent to repeated preliminary viewings of the data record films with the variable speed projector, two general forms of analyses of the data films were carried out. One of these was a descriptive analysis of time spent in looking within various areas of the visual field, responses made to auditory and visual cues, and a brief evaluation of certain other kinds of eye behavior. The second major type of analysis was a detailed study of the various eye-movement indices. The results of these analyses are discussed in the following sections.

DESCRIPTIVE ANALYSIS

Analysis of Subareas of the Visual Field

The preliminary viewings of the data revealed that there was a marked "clustering" of the eye marker. Although it might have been expected that subjects would look primarily at the main objects of interest in the field, it is nevertheless quite striking how strongly the eye markers were concentrated in a few well-defined areas. A descriptive analysis was made of what objects were observed by the subjects and the duration of each observation in order to describe the attention value or valence of the visual and verbal stimuli. Such distributions revealed what may operationally be regarded as the center or centers of attention of the scene. The total length of time that the eye marker appeared in each area, as well as the number of times it entered that area was recorded.

This analysis was performed on nine segments of the television lesson. In each case the stimulus field was divided into a number of areas within which an "important" element appeared. Not all points of the stimulus field were included in some area. In a dynamic scene the spatial position of each defined area within the stimulus field was not constant, but shifted with the element.

The apparatus to perform some of this analysis consisted of a specially constructed keyboard and a modified variable speed projector. This apparatus is illustrated in Figure 9. The keyboard could be operated by the analyst while he observed a projection of the data record films at a speed of four frames per second. This keyboard simultaneously operated an array of counters and a strip chart recorder which registered the data



Figure 9: Data Read-Out Using a Slow Speed Projector

encoded by the analyst on the keyboard. The counters operated in sets of two. When one of the buttons on the keyboard was pressed, a corresponding set of counters was activated. One of these recorded the duration, in terms of the number of frames, the eye marker was in that particular area; while the other counter recorded the total number of clusters in that area. The data encoded by the buttons on the keyboard were simultaneously recorded by the strip chart recorder. The resulting charts allow a display of this data as a function of time.

The data for five scenes analyzed with this equipment are presented below. Four other scenes which were analyzed with a film viewer to yield similar data are presented in a subsequent section.

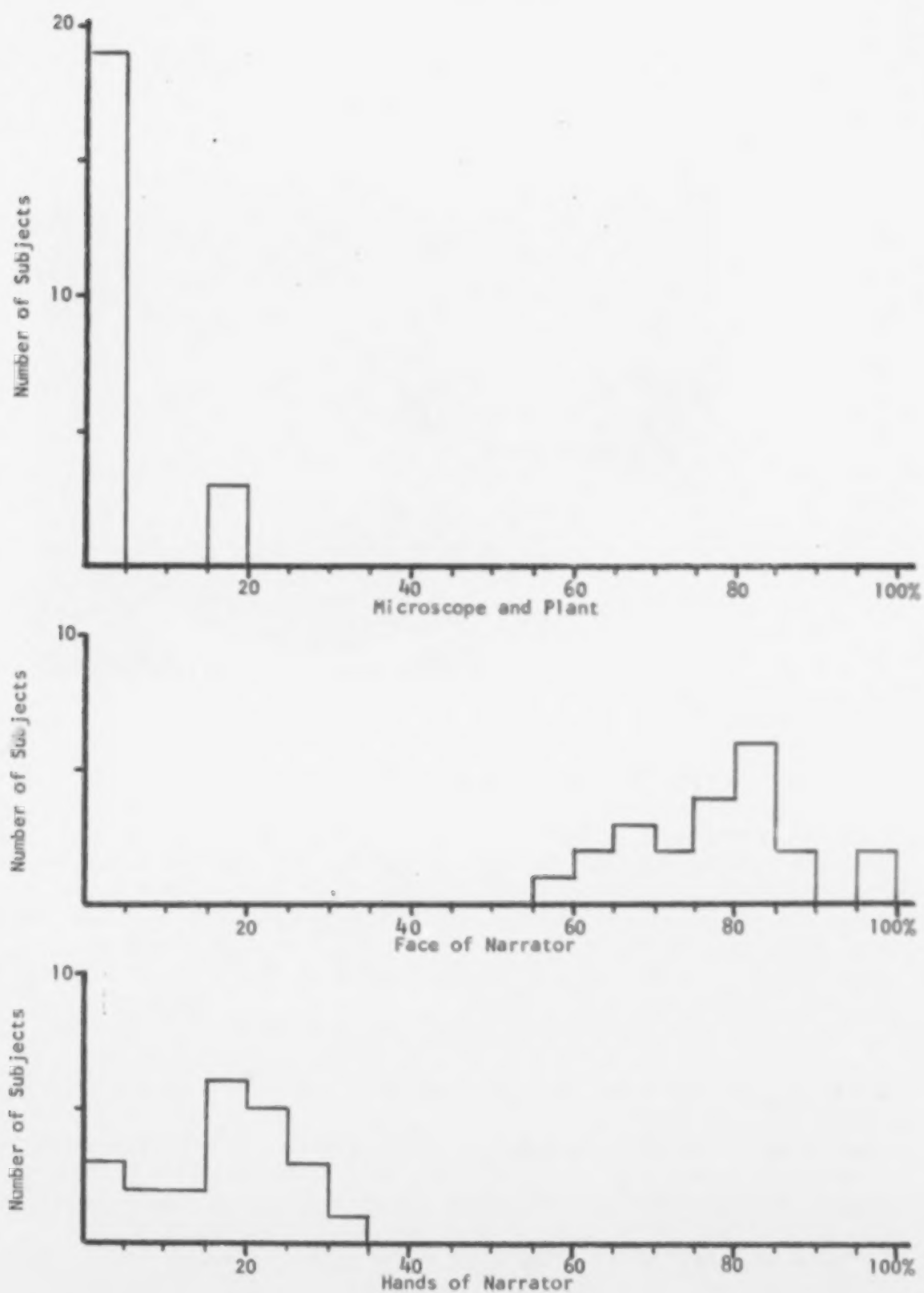


Figure 10: Distributions of Percentage of Total Time by Areas (Scene 10)



Figure 11: Representative Photos from Scene 10

Table 1

Mean Percentage of Total Time in Each Area

Microscope and Plant	2.7 per cent
Face of Narrator	77.1 per cent
Hands of Narrator	17.3 per cent
Off Stimulus Image	1.5 per cent

In this scene, as in other scenes in which the narrator appears, an appreciable amount of time is spent looking at the narrator's face. The amount of time spent looking at the narrator's hands is partly a result of the fact that he is manipulating and discussing two petri dishes. The microscope and plant in the background are not pertinent to the presumed intention of the lesson and, therefore, may be regarded as distractors. Although a mean time of only 2.7 per cent was spent on them, it should be noted that many subjects looked at the distractors several times.

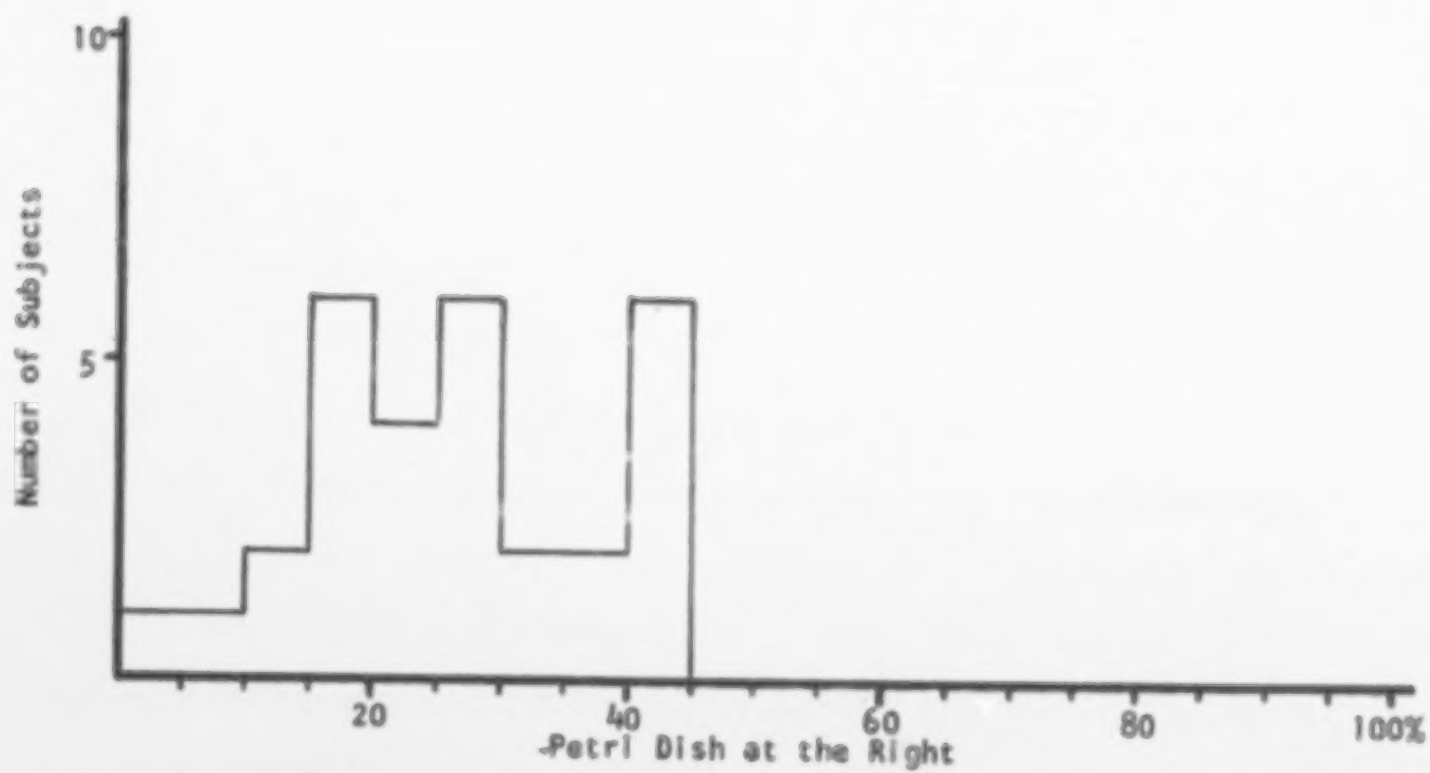
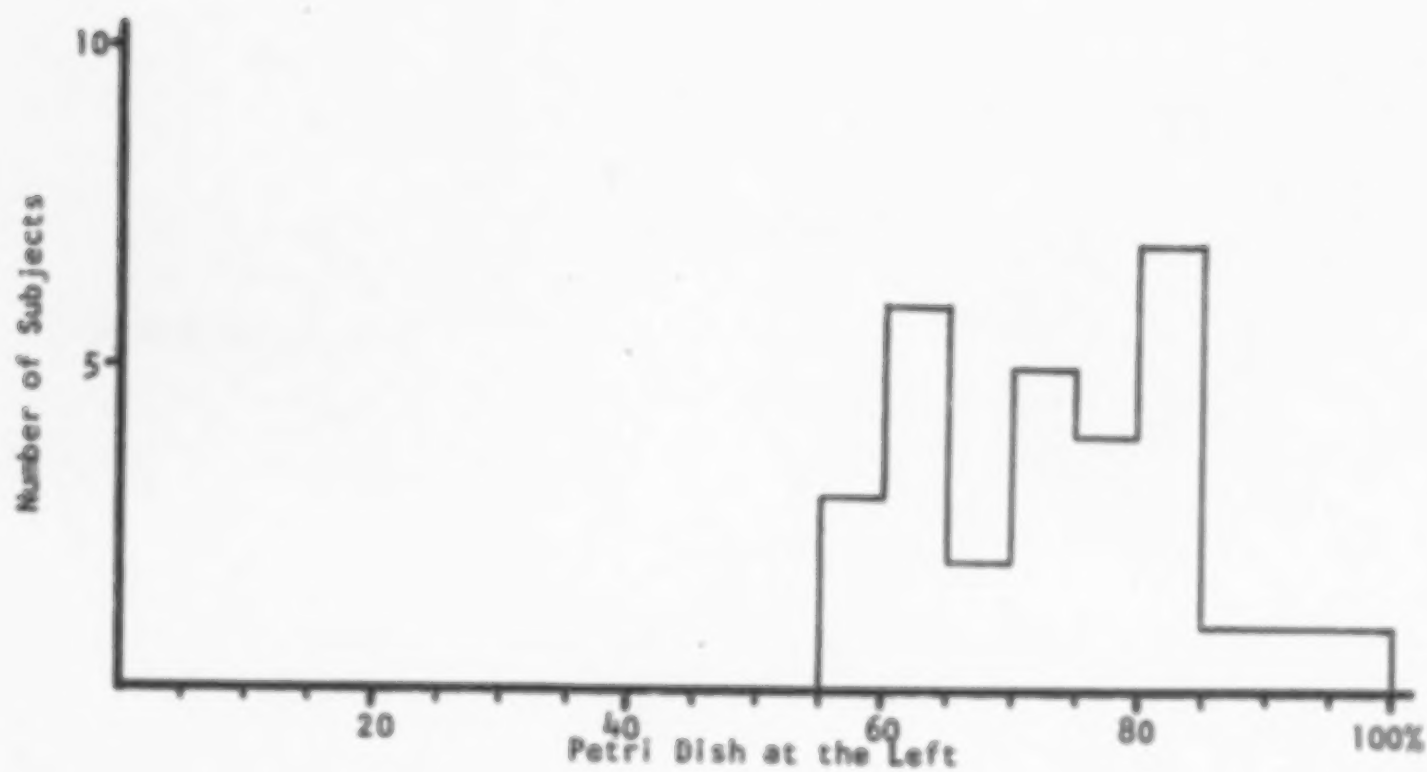


Figure 12: Distributions of Percentage of Total Time by Areas (Scene 11)



Figure 13: Representative Photo from Scene 11

Table 2

Mean Percentage of Total Time in Each Area

Petri Dish at the Left	73.0 per cent
Petri Dish at the Right	26.2 per cent
Off Stimulus Image	.9 per cent

This scene was a relatively static shot. That is, there was no movement except for one instance when the narrator tapped the petri dish at the right with his finger. In this scene the narrator discussed primarily the petri dish at the left. This petri dish is also a new element in the visual field, while the petri dish at the right had been shown already in a previous scene. The large difference in mean time spent on the two petri dishes, therefore, does not necessarily indicate a position preference.

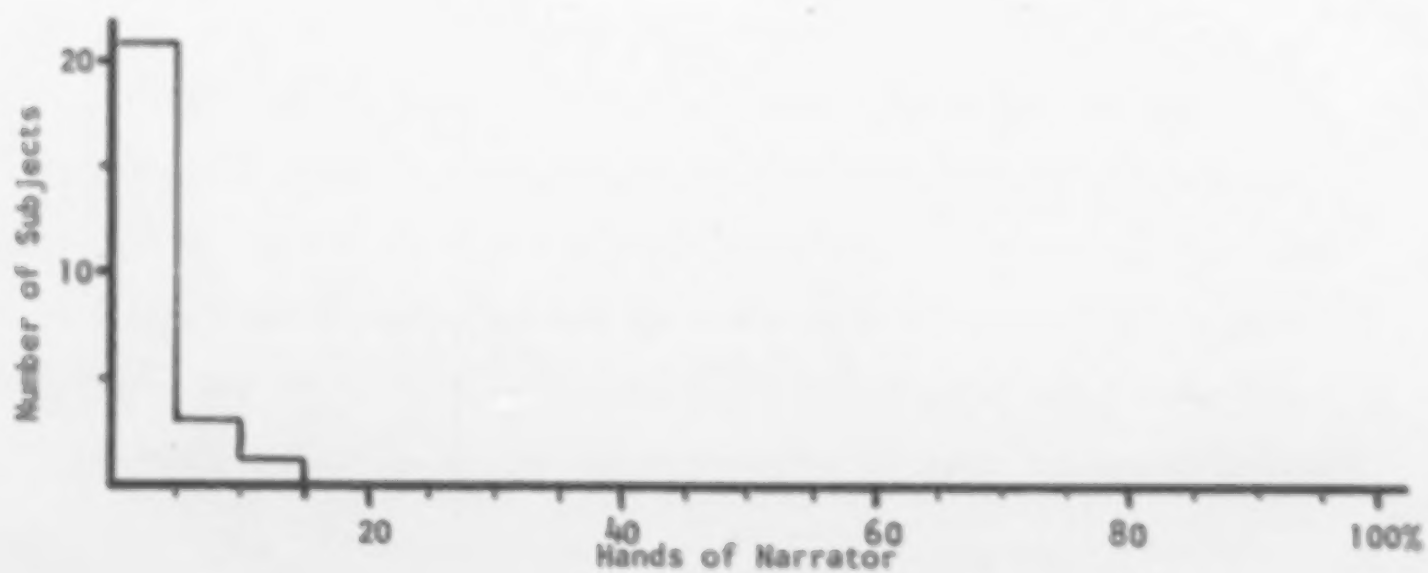
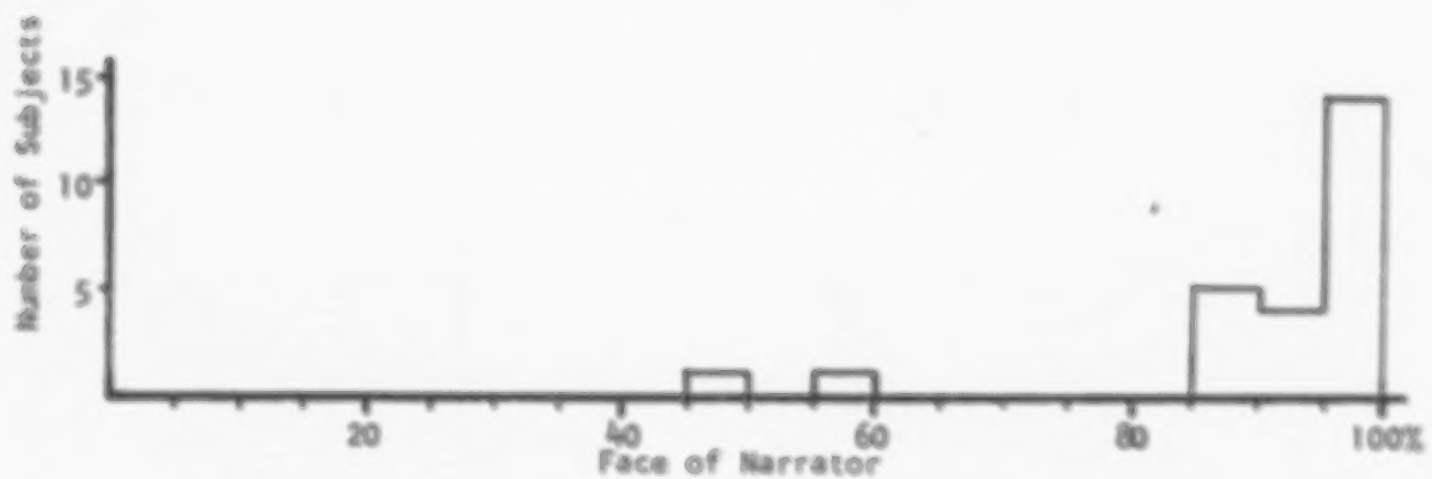
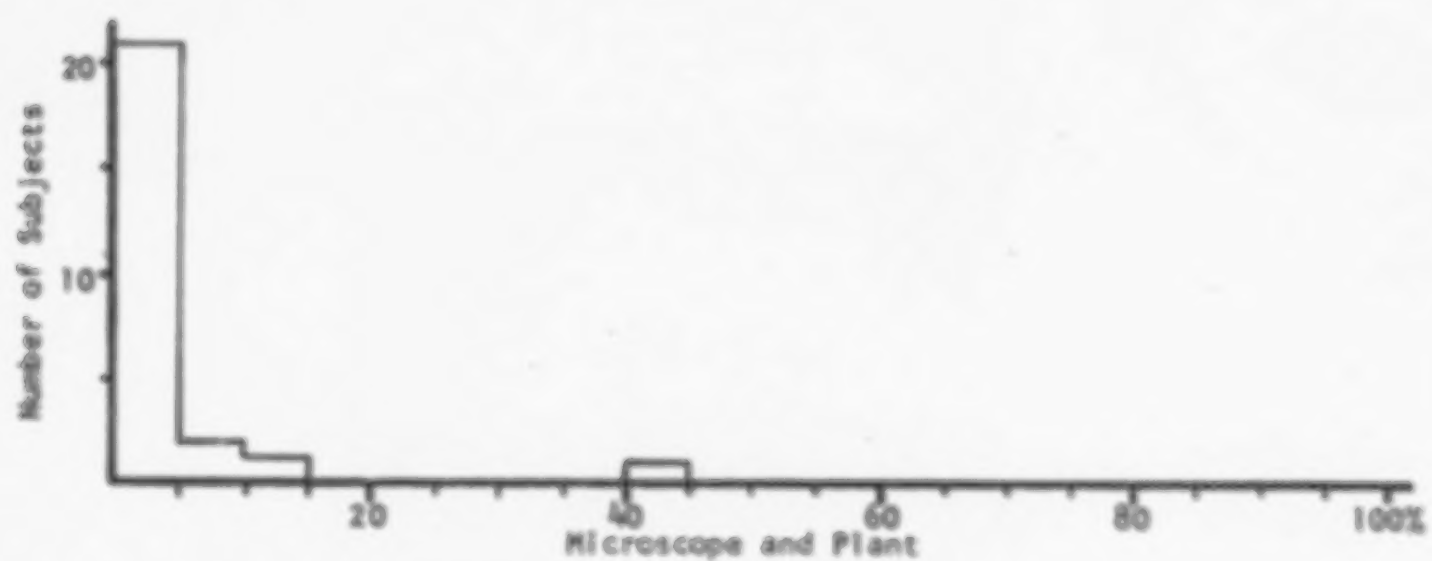


Figure 14: Distributions of Percentage of Total Time by Areas (Scene 21)



Figure 15: Representative Photos from Scene 21

Table 3

Mean Percentage of Total Time in Each Area

Microscope and Plant	3.4 per cent
Face of Narrator	91.9 per cent
Hands of Narrator	2.4 per cent
Off Stimulus Image	0 per cent

This scene is somewhat similar to Scene 10 for which data were presented previously. The time spent looking at the hands is only 2.4 per cent in contrast with 17.3 per cent in Scene 10. This represents the difference between simply gesturing in this scene and manipulating an object in Scene 10. It is obvious that the hands with an object command a great deal more attention.

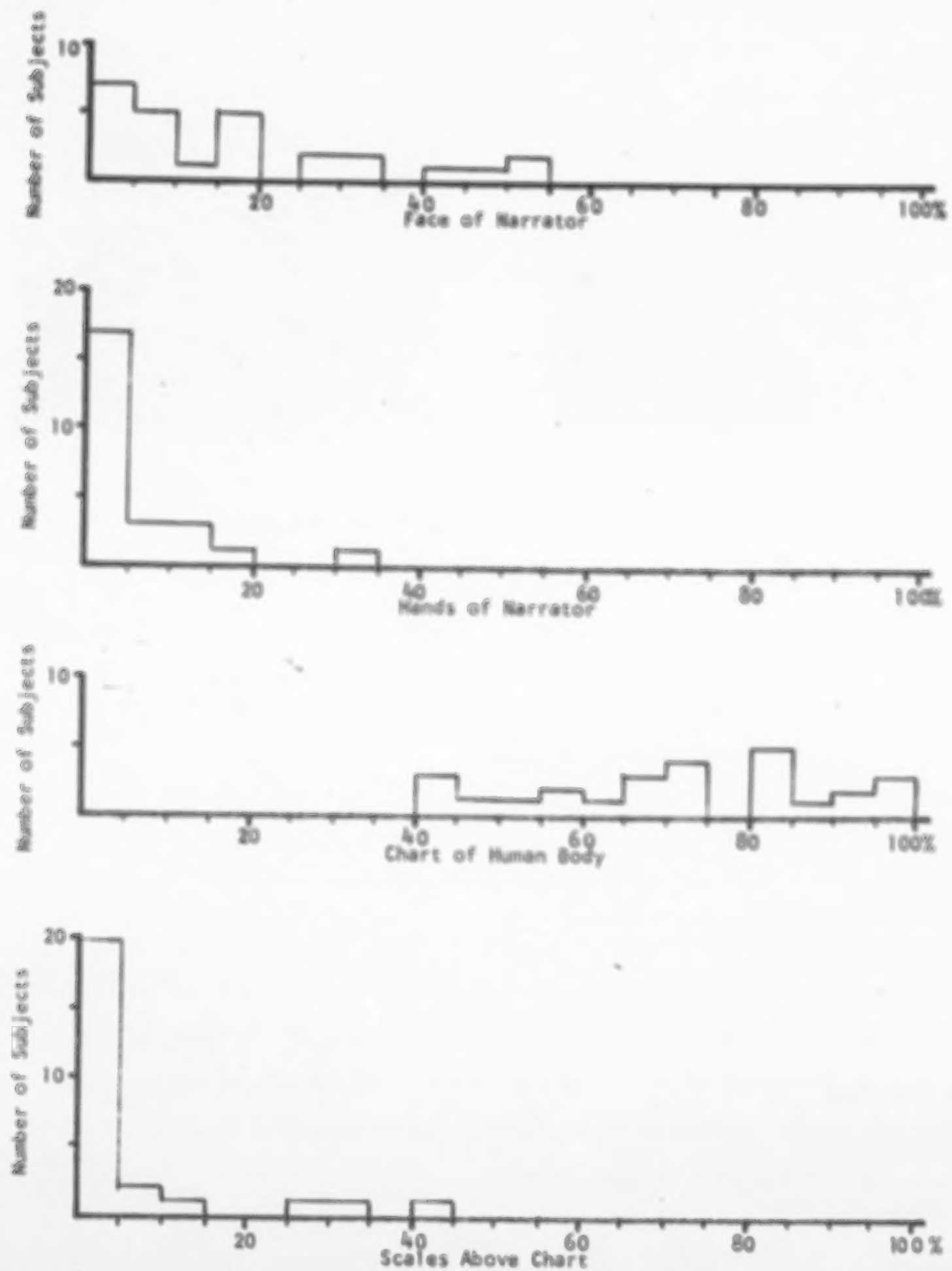


Figure 16: Distributions of Percentage of Total Time by Areas (Scene 23.2)



Figure 17: Representative Photos from Scene 23.2

Table 4

Mean Percentage of Total Time in Each Area

Face of Narrator	17.4 per cent
Hands of Narrator	4.6 per cent
Chart of Human Body	72.9 per cent
Scales above Chart	5.3 per cent
Off Stimulus Image	0 per cent

In this scene the emphasis of the subjects' attention shifts from the face of the narrator to the chart of the human body. This is no doubt due to the fact that the narrator refers to this chart throughout the scene.

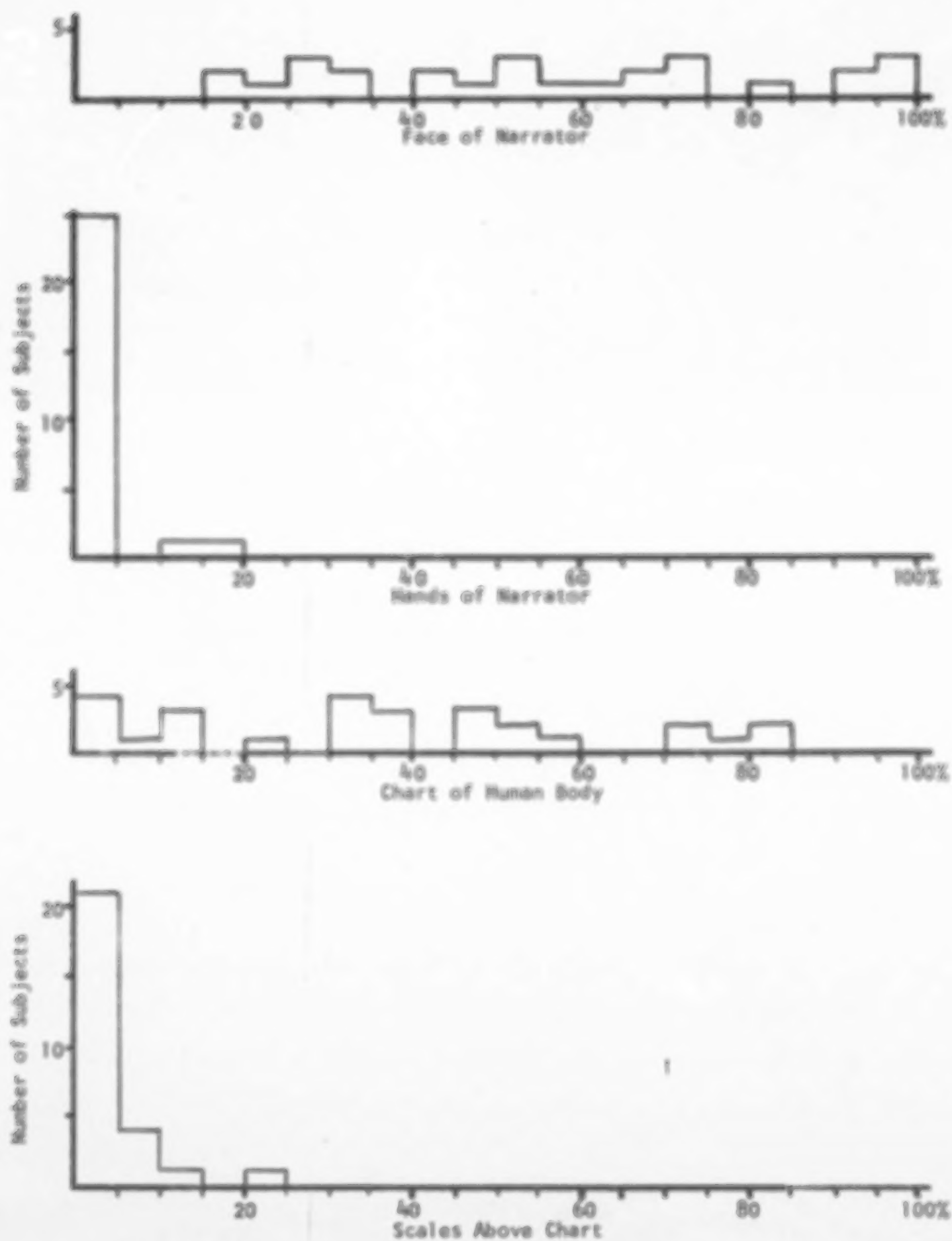


Figure 18: Distributions of Percentage of Total Time by Areas (Scene 25)



Figure 19: Representative Photos from Scene 25

Table 5

Mean Percentage of Total Time in Each Area

Face of Narrator	57.1 per cent
Hands of Narrator	1.8 per cent
Chart of Human Body	36.9 per cent
Scales above Chart	3.3 per cent
Off Stimulus Image	1.0 per cent

This scene is very similar visually to Scene 23.2, but contrasts in the relationship of audio and visual material. In Scene 23.2 the narrator was discussing the chart appearing beside him, while in this scene he is discussing another topic not related to the chart. Therefore, the chart may be regarded as a distractor during this scene. The fact that the subjects nevertheless spend a mean of 37 per cent of their total time looking at this chart implies that unrelated material may become a significant distractor in some instances.

These data regarding time spent in looking within various subareas of the visual field indicate that the subjects exhibit a tendency to look at the following: the face of the narrator when he appears in the field, the narrator's hands when he manipulates any object, and objects to which attention is directed by the narrator. Other objects in the visual field which do not serve the presumed intention of the lesson, therefore termed distractors, may draw a fair amount of attention from the relevant material.

There was high variability among subjects in the amount of time spent looking at the various areas of the visual field. Generally speaking, a significant correlation with total IQ was not found for most of these data. Using the Mann-Whitney U Test with "high" (above 115) and "low" (below 100) IQ groups for an N of 15, however, a significant difference was found in Scene 23.2 for the combined areas of chart and scales. A combination of these immediately adjacent areas was necessary for this test since the initial responses of the subjects indicated that they might have thought the scales and chart to be related. In Scene 23.2 where the narrator is discussing the chart beside him, the "high" IQ group spent more time looking at this chart than did the "low" IQ group. This difference was significant at the 2 per cent level. A significant difference was not found for the comparable data of Scene 25 in which the narrator does not discuss the chart. In taking the difference in time spent on this combined area for the two scenes, a difference was found for the two IQ groups. The "high" IQ groups spent more time looking at the chart in Scene 23.2 where it is discussed than in Scene 25 where it is not as compared to the low IQ groups. This difference was significant at the 10 per cent level.

Four of the data film sequences which were selected for the general descriptive analysis could not be handled easily with the projector apparatus described previously. It was desired to divide one of these sequences into a number of segments. These desired subdivisions in the film could not be accurately discriminated via the projector. For the other data the areas to be defined were quite small or their spatial arrangement was such that discrimination among them was again difficult. These sections of the data films, therefore, were analyzed with the use of a film viewer, as illustrated in Figure 20, which made it possible to analyze each individual frame for as long as was desired. The data read out with this method was recorded manually on work sheets and later synthesized. Film quality for some subjects and certain scenes was not sufficient for analysis using the film viewer.



Figure 20: Data Read Out Using a Film Viewer

Table 6

Scenes Selected for Analysis by Viewer

Scene	Description	Average Number of Frames	Time in Seconds	Number of Subjects
15.	Demonstration by Narrator of Cleaning Aids	492	26.6	17
16.2	Close-up Panning Shot of Hand Brush and Nail File	78	4.2	10
22.	Growth of Bacterium	541	29.2	10
34.4	Superposition of CARBOHYDRATES Over Close- up of the Potato and Sugar	212	11.5	8

Each scene was divided into specified areas usually defined in terms of the physical objects in that area. Two measures were recorded and tabulated: the duration of response in terms of the per cent of total time of each scene which each subject's eye marker was in a particular area and the occurrence of response, i.e. the number of times the eye marker entered a particular area.

Scene 15

Figure 21 presents a representative photo from Scene 15 in which the narrator is discussing and handling each of the cleaning aids (soap, hand brush, nail file, and shampoo bottle) from the tray before him. Table 7 presents the means and standard deviations of the duration and occurrence of responses to each area for a sample of 17 subjects. Some of the areas are self-explanatory with the possible exceptions of:

- Area 5: Background objects. The microscope and other objects not pertinent to the presumed intention of the scene.
- Area 6: Off image, but visible. The eye marker can be seen in the vicinity of the simulated television set but is not located within the area of the image field.
- Area 7: Eye marker not visible. It was impossible to determine where the subject was looking. The subject may have been looking around the room beyond the angular extent of the television lens, his eyes may have been closed, or the eye marker may have become defocused.
- Area 8: Intermediate position. At infrequent intervals a subject appeared to be looking at the narrator's chest, shoulder or at various unspecified locations within the telelesson.
- Area 9: Blink. Operationally, the eye marker would abruptly disappear or slide up and off the screen for a few frames and then return to the field of view with a vertical slide.

Table 7 indicates that fifth grade children watching an educational television scene in which a narrator is discussing and handling various objects spend, on the average, approximately one third of their time on the narrator's face. The duration of response to this area reveals greater variability between individuals, however, than any other area



• Figure 21: Representative Photo from Scene 15

Table 7

Scene 15: Means and Standard Deviations for Response
Duration and Occurrence. N = 17.

Area Code	Place or Object	Duration (% of total time)		Occurrence (entries into area)	
		M	SD	M	SD
1	Narrator's face	30.7	16.3	6.5	2.4
2	Hands holding objects	23.7	11.1	5.7	2.6
3	Hands, no object	3.7	3.7	1.5	1.6
2&3	Hands	27.4	11.9	7.2	2.9
4	Tray and cleaning aids	14.6	10.4	3.9	2.1
2&4	Objects on tray or in hands	38.3		9.6	
5	Objects in background	5.5	6.0	2.1	1.7
6	Off image, but visible	2.7	4.9	.9	2.3
7	Eye marker not visible	10.8	19.3	1.2	2.1
8	Intermediate positions	5.4	4.9	1.8	1.6
9	Blink	3.6	2.5	4.6	3.2

within the image field; some subjects spending less than 10% with others spending over 50% of their time watching the face.

Arm movements and gestures used only to emphasize the verbal commentary did not appear to attract much attention. However, when such movements directly involved the objects being discussed, the amount of time spent looking at the hands increased. The combined Area 2 & 3 (hands with and without an object) was looked at more frequently but with slightly shorter duration than the face. The total response to the narrator's hands

approached the same level of response in terms of duration as the face, the face receiving 30% and the hands receiving 27% of the subject's time.

The implied "subject matter" of Scene 15 was the cleaning aids. While these objects remained on a tray in front of the narrator they were looked at only 15% of the time, but if one adds to this figure the per cent of time that the cleaning aids were regarded while the narrator handled them (Areas 2 & 4), the cleaning aids received attention 38% of the time, surpassing the time spent looking at the narrator's face.

Area 5 (objects in the background) and possibly Area 6 (off image, but visible) of the scene can be classified as distractors. The background objects were looked at on an average of 5.5%, and the time which the eye marker was visible outside of the image field averaged 2%. The relatively large standard deviations associated with each of these means indicate that some subjects were distracted considerably more than the mean value.

A cursory examination was made of the hypothesis that general viewing habits or patterns might be different depending upon an individual's intelligence. This sample of 17 subjects was divided into two groups on the basis of their overall IQ in the California Test of Mental Maturity. The upper IQ group consisted of 9 subjects whose IQ's ranged from 102 to 135, while the lower IQ group consisted of the other 8 subjects with IQ's ranging from 70 to 101. Table 8 presents the means, standard deviations, and differences between the means for these subsamples in terms of duration and occurrence of response. The mean of the lower IQ group was always subtracted from the mean of the higher IQ group; hence, the plus and minus signs indicate the direction of the differences. These differences were also tested for significance using Student's t-test.

Table 8

Scene 15: Means, Standard Deviations, and Differences
Between Upper and Lower IQ Groups

Duration						
Area Code	Upper IQ		Lower IQ		Difference	t
	M (N = 9)	SD	M (N = 8)	SD		
1	32.4	17.1	28.7	15.1	+3.68	.443
2	26.9	6.9	20.9	13.9	+5.916	1.023
3	4.3	4.2	3.0	2.8	+1.251	.689
2&3	31.1	6.8	23.3	14.7	+7.869	1.306
4	19.5	9.6	9.0	8.2	+10.511	2.193 (p=.05)
5	3.7	5.6	7.5	5.8	-3.871	1.311
6	.4	.9	3.8	6.5	-3.416	1.387
7	4.5	9.9	17.8	24.3	-13.314	1.361
8	3.9	4.5	7.1	4.7	-3.130	1.317
9	4.4	2.8	2.7	1.5	+1.689	1.491
Occurrence						
1	7.1	2.8	5.9	1.5	+1.225	1.066
2	6.4	2.3	4.9	1.0	+1.569	1.232
3	1.4	1.3	1.6	.5	-.181	.27
2&3	7.9	2.7	6.5	1.1	+1.3889	.9487
4	4.8	2.0	2.8	.7	+2.0278	2.0618 (p=.07)
5	1.7	1.2	2.5	.8	-.8333	.952
6	.3	.5	1.5	.4	-1.1667	2.7387 (p=.02)
7	.3	.7	2.1	1.0	-1.7917	1.7025
8	1.4	1.2	2.3	.7	-1.0556	1.2985
9	5.9	1.2	3.1	.7	+2.7638	1.8951

The upper IQ group exhibited a higher mean than the lower IQ group in the Areas 1, 2, 3, 4 and 9 while the lower IQ group exhibited a higher mean in Areas 5, 6, 7 and 8. Thus Table 8 shows a positive difference for the face, hands with and without objects, the tray and cleaning aids and a negative difference for objects in background, off image, eye marker not visible, and intermediary positions. Particularly noteworthy are the differences between the means of the two groups with respect to Area 4 (tray and cleaning aids). In terms of the duration of response this difference is significant at the .05 level and in terms of the occurrence of response this difference is significant at the .07 level.

The observation that the upper IQ group spent more time than the lower IQ group regarding the areas most pertinent to the teaching intention of Scene 15 is in accordance with the expectation that more intelligent individuals are better able to cope with elements in their environment than less intelligent individuals. The lower IQ group spent more time than the upper IQ group looking at distractors, around the edge of the television set, and off the image as is reflected in their responses to Areas 5, 6, 7 and 8. One of the more interesting findings from the examination of this scene, is that the upper IQ group spent 46.4% of their time regarding Areas 2 and 4 combined (cleaning aids on tray or in hands) while the lower IQ group devoted only 29.9% of their time regarding these objects of prime importance. It should be remembered that these objects are essential elements in the demonstration and, therefore, of prime importance as "subject matter."

Scene 16.2

This scene involves the use of a type of camera motion termed "panning." The scene begins when the nail file and brush first appear at the left of the screen and terminates when they disappear to the right.

Table 9 presents the duration and occurrence of response. Although it had not been anticipated, the relatively small intermediate area between the brush and nail file was looked at by every subject; hence, this area was labeled Area 2.

Table 9

Scene 16.2: Means and Standard Deviations for Response Duration and Occurrence. N = 10.

Area Code	Place or Object	Duration (% of total time)		Occurrence (entries into area)	
		M	SD	M	SD
1	Brush	42.4	20.8	2.0	.6
2	Between brush & file	18.6	7.2	1.3	.8
3	File	22.3	24.4	1.3	1.1
4	Elsewhere in Scene	13.3	10.2	1.4	.8
5	Off image, but visible	0	0	0	0
6	Eye marker not visible	0	0	0	0
7	Blink	3.6	5.7	.6	.8

From the photograph in Figure 22, it can be seen that the visibility of the nail file is considerably greater than the visibility of the transparent plastic brush. Subjects spent on the average twice as much time



Figure 22: Representative Photo from Scene 16.2

regarding the brush as they did the nail file. Note also that Areas 4 and 5 (off image, but visible and eye marker not visible) received zero responses.

Scene 22

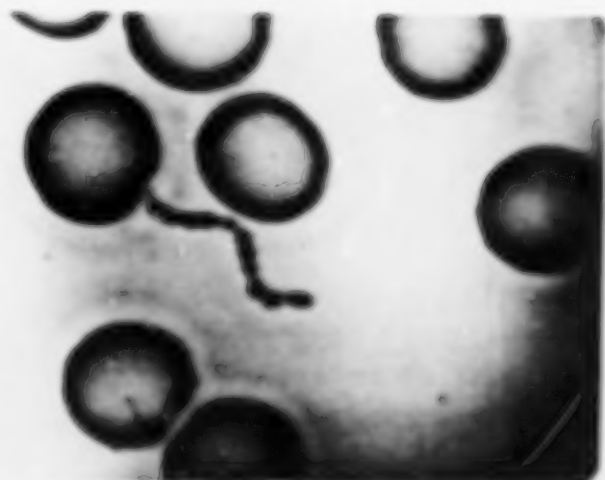
This relatively long scene was divided in two ways: (1) according to time and (2) according to areas. The division according to time produced 3 time segments:

- (1) Time segment 1: A static shot depicting a bacterium and some red blood cells.
- (2) Time segment 2: A dynamic scene in which the bacterium begins to grow and spreads.
- (3) Time segment 3: Also a dynamic scene in which the bacterium continues to grow, filling the screen and destroying red blood cells.

Single representative photos from two of the three time segments are presented in Figure 23.

The image field was arbitrarily divided vertically into three equal areas numbered from the left to the right as Areas 1, 2, and 3. Table 10 displays the means and standard deviations of duration and occurrence of response to specified areas in each of the three time segments.

This scene displayed a bacterium (centrally located at first) and red blood cells. During the first time segment in which no motion was involved the central area was looked at 85% of the time. However, as time progressed, less time was spent on the central area and more on Areas 1 and 3. During the second and third time segments in which the bacterium begins to grow, extending out from the center and soon filling the screen, the central area continues to be looked at longer than the right or left third of the screen, despite the fact that much activity takes place in these outer areas.



Time Segment 1



Time Segment 3

Figure 23: Representative Photos of Two Time Segments from Scene 22

Table 10

Scene 22: Mean and Standard Deviations for Response
Duration and Occurrence. N = 10.

Area Code	Place or Object	Duration (% of Total Time)		Occurrence (Entries into Area)	
		M	SD	M	SD
<u>Time Segment 1: (144 frames)</u>					
1	Left third	6.9	9.4	1.2	1.4
2	Center third	85.6	10.4	2.6	1.2
3	Right third	1.6	3.9	.3	.6
4	Off image, but visible	0	0	0	0
5	Eye marker not visible	.9	2.7	.2	.6
6	Blink	5.0	3.6	1.8	.9
<u>Time Segment 2: (234 frames)</u>					
1	Left third	14.1	9.2	2.2	1.5
2	Center third	55.7	12.4	4.7	1.6
3	Right third	23.0	13.1	3.0	1.4
4	Off image, but visible	1.1	3.3	.1	.3
5	Eye marker not visible	.8	1.7	.2	.4
6	Blink	5.3	5.7	2.0	1.9
<u>Time Segment 3: (163 frames)</u>					
1	Left third	33.8	13.1	2.5	1.0
2	Center third	47.5	14.5	3.3	1.1
3	Right third	16.4	13.6	1.7	1.0
4	Off image, but visible	0	0	0	0
5	Eye marker not visible	0	0	0	0
6	Blink	2.3	2.0	.9	.7

Scene 22 contained both static and dynamic elements; time segment 1 presented a static field while segments 2 and 3 presented dynamic fields. To permit a comparison of the frequency of response across the three segments, each containing a different number of frames, it was necessary to sum for each of these the occurrence of response for all three areas

comprising the stimulus field (Areas 1, 2 and 3). This sum for each time segment was then divided by the number of frames comprising it. The resulting quotient was multiplied by the number of frames recorded per minute yielding an average frequency of response which could be compared across different time segments. This frequency of response or frequency of shifts between areas reflects an overall scanning activity level associated with each time segment and is presented in Table 11.

Table 11
Overall Scanning Activity Level for the Three
Time Segments in Scene 22

Time Segment	Mean Occurrences Summed	Number of Frames	Shifts Between Areas Per Min.
1	4.1	144	31.5
2	9.9	234	47.25
3	7.5	163	51.75

As the scene changes from a static scene to a dynamic one (from time segment 1 to 2) the frequency of scanning responses shows a marked increase. As the scene becomes more involved and, in a way, more dramatic as red blood cells rapidly disintegrate (from time segment 2 to 3) there is only a very slight increase in the frequency of scanning responses.

Scene 34.4

This scene consisted of the word "Carbohydrates" superimposed over a close-up shot of a cut potato and some sugar as represented in Figure 24.



Figure 24: Representative Photo from Scene 34.4

During this scene the narrator discussed the origin of the syllables "Carb," "o," and "hy," not referring to "drates" except in pronouncing the entire word. Table 12 presents the means and standard deviations in duration and occurrence of response for eight subjects. One subject in this sample did not look at the superimposed word at all; instead he looked briefly at the other objects in the scene and then looked around the room. Therefore, data is also presented in Table 12 for the remaining seven subjects.

On the average, fifth-grade children looked at the first part of this fairly complex superpositioned word which received heavy auditory support about 50% of their time. The last portion of the word which received little or no auditory support was looked at only 20% of the time.

Table 12

Scene 34.4: Means and Standard Deviations for Response Duration and Occurrence of Two Subject Groups

Area Code	Object or Place	Duration (% of Total Time)				Occurrence (Entries into Area)			
		N = 8		N = 7		N = 8		N = 7	
		M	SD	M	SD	M	SD	M	SD
1	"Carbohy"	46.4	27.3	53.1	21.4	4.0	2.3	4.6	1.7
2	"drates"	19.0	14.8	21.7	13.7	3.1	2.5	3.6	2.4
3	Other objects	14.9	15.3	16.2	16.1	3.0	2.3	3.3	2.3
4	Off image, but visible	0	0	0	0	0	0	0	0
5	Eye marker not visible	14.7	32.7	3.3	5.9	.4	.5	.3	.5
6	Blink	5.0	5.1	5.7	5.0	2.1	1.6	2.4	1.5

The analysis of data film using the viewer has made possible the examination of eye-movement responses for various periods in the development of a scene. This viewer technique also allowed a finer examination of various areas within the stimulus field than was possible with the projector.

In summarizing the findings presented above, the analysis of data film using the viewer supports the general findings from the projector analysis. On a specific level, the most salient finding is the differential response to specific areas given by different IQ groups in Scene 15. The high IQ group spent significantly more time upon areas which included items pertinent to the intention of the scene and significantly less time than the lower IQ group on areas which were insignificant to the lesson content.

Some Other Types of Eye-Movement Responses

From observations during the experimental sessions and preliminary observations of the data films at regular projection speeds, some responses other than "clustering" were noted. These include reactions to specific cues and other eye behavior such as "blooming," "sliding," and "surrender-type" responses. A general descriptive analysis for these phenomena was made via a check-list. These data are very inferential, and most of the check-list items which had been assembled could not be scored reliably. The difficulty in scoring these items was largely due to the method of obtaining these data.

Only one purely auditory cue occurred in the stimulus film: the narrator referred to a particular blood cell during the film clip of Scene 22. Only three of the twenty-nine subjects for which a relatively clear judgment could be made did not look at this cell after the narrator drew attention to it. Seven of the subjects could not be scored since they were already looking within this area before a reference was made to it by the narrator. The remaining check-list items referred to visual cues. It was found that most subjects will switch their gaze to a new object which is introduced in the visual field. An accurate scoring of responses to such cues, however, was also not possible.

Blooming and sliding were also scored with the check-list. The term "blooming" is used to characterize variations in the size and shape of the eye marker. The majority of low IQ subjects displayed a large amount of blooming. Investigation of this phenomena has shown that blooming represents, basically, a change of focus of the corneal reflection beam. Such

changes of focus are probably due mainly to translational movements of the eye forward and backward in its socket. It is also obvious, however, that some of the blooming is a result of helmet slippage. This type of blooming has been called "long-term" since it will often continue through two or three scenes. Six subjects exhibited "long-term" blooming.

Another type of blooming is of a transitory nature. The blooming frequently occurs when the eye marker is not on a center of attention. Upon the introduction of a new object, movement of some type, or a scene transition, the eye marker shifts abruptly to some object in the field and the blooming ceases. This type of blooming was exhibited by many subjects more than once while seven subjects exhibited it frequently. A majority of low IQ subjects displayed a large amount of blooming. It is conceivable that this phenomenon, when better understood, may be utilized as an attention index, the application of which is apparent.

Gross sliding detected by means of the slow projector refers to large sweeps of the eye marker through the visual field, often traveling completely off the image. These slides differ from those later discussed in viewer analysis by their great extent. This marked sliding behavior was exhibited by only a few subjects.

This phenomenon may be the result of a number of factors. It is possible that a subject exhibiting gross sliding actually does look off the stimulus field frequently when his eye marker exhibits a sweeping type action. However, there is another feasible explanation. Since this same gross sliding behavior was also exhibited by one subject who was a suppressor in the left eye, which is the eye from which recordings are made, it is possible that this eye-marker behavior is of a disjunctive nature.

Extreme gross phorial tendencies, for example, may be related to gross sliding behavior. In this case, because the left eye from which the recording is made is partially occluded and also somewhat blinded by the corneal reflection light source, the eye may have a tendency to drift to some point and act somewhat independently of the right eye. It had been hoped that since the left eye is only partially occluded, enough of the visual field would be available to this eye that normal phorial tendencies would not come significantly into play. This appeared to be true for most subjects, but the gross sliding tendencies of these five subjects are open to question. A check of the degree of phorial tendency was not included in the pre-experimental examination of the subjects; therefore, it is not possible to answer the question of the nature of the gross slides from this pilot study.

Since the West Side Story sequence was included after the telelesson and only fifteen minutes of the stimulus material could be recorded, only a portion of this sequence was included in the permanent data film. However, from observations during the experimental runs an interesting phenomenon was detected during this sequence. As the segment first appears on the screen, most subjects attempt to track, that is, to follow visually moving objects. Many subjects soon discover, however, that it is literally impossible to follow all of the objects that are introduced into the scene. Their initial tendency to track is replaced by a central fixation; that is, the subjects select a point near the center of the screen and continue to focus approximately on that point. It would appear likely that visually following objects which appear suddenly and move extremely fast is such a demanding task that the subject attempts instead of fixating directly, to utilize peripheral

vision in keeping abreast of events in the visual field. However, this does not appear to be the case since subjects are not able subsequently to recall the specifics of what was in the peripheral field. Thus, the behavior exhibited is probably not a coping method, but simply a surrender or withdrawal from an impossible task.

While these observations are interesting, and provocative, the unreliability of the technique for obtaining the data prevent the drawing of conclusions. It will be necessary to test these phenomena in a further study before definite observations can be made.

ANALYSIS IN TERMS OF EYE MOVEMENT INDICES

Introduction and Definitions

It became apparent during the initial data analysis phase of the present project that indices based on the standard fixation concept would be inadequate for the data. When the data films were examined on a frame-by-frame basis with a film editor (Figure 20), it was noticed immediately that all of the observable phenomena could not be classified as either fixations or saccades. An appreciable amount of eye movement was found falling between these two extremes. Instead of a dichotomy it was necessary to define four classifications of eye movements. These new eye-movement indices represent various intervals of a continuum between the extreme points generally identified as fixations and saccades.

The extreme of the continuum analogous to the "fixation" of other researchers is termed NO OBSERVABLE MOVEMENT (NOM). In operational terms, when the position of the eye marker has not observably changed between two successive frames, this series of frames is termed a NOM. It is sometimes difficult to identify a NOM because of several problems in the viewer analysis technique. The image field is dynamic and, thus, when the eye marker and the stimulus both move simultaneously through a small distance the eye marker does not remain a constant size throughout the film. In addition to this intra-subject variability the eye-marker size also varies between subjects. The variability was found to lie between 0.75 degrees and 1.5 degrees of visual arc with a mean diameter of one degree. Because of these errors, it is possible that some eye movements with a displacement of the eye marker of about thirty minutes of arc during the total sequence of

data film frames may be classified as NO OBSERVABLE MOVEMENT. This index includes, therefore, most of the tremors, drifts, and physiological nystagmus of various other researchers.

The other extreme of this continuum is termed SACCADE and represents essentially what has been termed saccade by other researchers. In operational terms the position of the eye marker has observably changed between two successive frames; the distance between positions being greater than the diameter of the eye marker, but the distance traversed by the eye marker before and after this event is less than the diameter of the eye marker.

It should be noted here that the diameter of the eye marker was used as the operational unit of extent. This diameter corresponds to about one degree of visual arc.

Between these extremes of the continuum three other categories, or indices, were defined. The smallest of these movements was barely perceptible through the use of a single-frame viewer. Frequently, it was only after several successive frames had been examined that the analyst could ascertain that one of these movements had occurred. On going back and re-checking frame-by-frame, he could see that the position of the eye marker had observably changed between two successive frames; and that the distance between positions was usually much less than the diameter of the eye marker. These movements have been termed MINIMOVEMENTS (MIN). In operational terms, the position of the eye marker has observably changed between two successive frames; the distance between positions being less than the diameter of the eye marker.

The MINIMOVEMENTS had a minimum extent of approximately fifteen to twenty minutes of visual arc. Recent eye-movement studies have revealed

that fixation does not correspond to a single fixed point, but consists, rather, of minute excursions, or oscillations, about the point being observed. When the eyes shift to a new point in the visual field, the initial saccade is generally followed by minor corrective movements, some of which may be small saccades if a substantial amount of correction is required. Such small "non-saccadic" movements are of a magnitude of a few minutes or even seconds of arc. The physiological nystagmus-type movements differ from the MINS reported in this study primarily in that they have less extent or, at least, they are at the lower end of this category.

Observed in the intermediate range, that is, between NEMS and SACCADES were eye movements here termed SLIDES. These occur when the position of the eye marker has observably changed between three successive frames and the distance between the first and second positions, and the second and third positions are each greater than the diameter of the eye marker.

Within this category a distinction was made between SMALL and LARGE SLIDES. It was noticed that the SMALL SLIDES, which were of lesser extent and slower velocity, were the ones showing the greater relation to the visual stimulus. The LARGE SLIDES, on the other hand, were faster and covered a greater distance. Operationally, the latter are similar to the slower SACCADES. A summary of the operational definitions for these various eye-movement indices is presented in Table 13.

Analysis

For purposes of analysis, two scenes were selected. The first scene (Scene 15--dynamic) is a demonstration and discussion by a narrator of a number of cleaning aids (brush, soap, etc.). The second scene (Scene 26--

Table 13
Summary of Definitions

NO OBSERVABLE MOVEMENT: (NOM)

The position of the eye marker has not observably changed between two successive frames.

MINIMOVENTS: (MIN)

The position of the eye marker has observably changed between two successive frames; the distance between positions being less than the diameter of the eye marker.

SLIDES:

The position of the eye marker has observably changed between three successive frames; the distance between the first and second positions, and the second and third positions are each greater than the diameter of the eye marker.

SACCADES:

The position of the eye marker has observably changed between two successive frames; the distance between positions being greater than the diameter of the eye marker, but, the distance traversed by the eye marker before and after this event is less than the diameter of the eye marker.

static) is a diagram of red and white blood cells. In the latter, no narrator is present and the picture is static throughout the entire sequence. The first scene is referred to as the "dynamic" scene; the latter as the "static" scene. Representative photos from these two scenes are presented in Figure 25 and Figure 26.



Figure 25: Representative Photo
From Scene 15

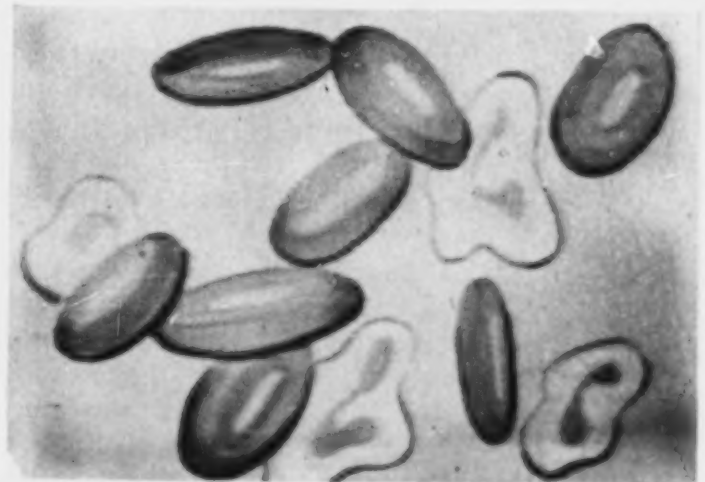


Figure 26: Representative Photo
From Scene 26

Data were tabulated for fourteen subjects on Scene 26--five in the high IQ range, five in the normal range, and four in the low IQ range. On Scene 15 only the high and low IQ groups were examined. The indices were recorded in terms of total duration; that is, in terms of the proportions of total number of data film frames for this scene that were classified into each category. The total durations for NOMS, MINS, SMALL SLIDES, LARGE SLIDES, and SACCADES, were calculated for each subject on each scene. At times the eye marker was not visible for various reasons, and the total duration of "lost eye marker" was also calculated. Similarly, the total occurrence for these indices were recorded; that is, the proportion

for each index of the total number of events of all the various types of eye movements during the scene.

Since the scenes differ in length, the eye-movement data are given in terms of proportions. As previously noted, a significant amount of the eye-movement data fall between the extremes classified as fixations and saccades in earlier studies.

Simple Eye-Movement Indices and Relations to CTMM Measures

Tables 14 and 15 give the means and standard deviations in terms of duration and occurrence, respectively, for each of the indices from NOMS to SACCADES for the two scenes examined. The peaks at the two ends of the frequency distributions, which are given in graph form in Figures 27 and 28, reflect the fixation and saccade indices of many other researchers in reading and static fields. In the present study, however, the lower end of the continuum, representing very small and slow movements of the eye is divided into two indices--NOMS and MINS. It is evident that, qualitatively, the rather high and well defined peak existing at the lower end of the continuum is independent of the type of scene, i.e., whether dynamic or static. However, this end of the continuum is clearly related to I.Q.

The most striking and consistent qualitative difference between high I.Q. and low I.Q. groups is in the relative frequency of NOMS and MINS. Correlations using I.Q., M.A., and two specific sub-tests of the CTMM (Non-Language M.A., and Spatial Relations) as the dependent variables and the various eye-movement indices as the independent variables were computed for duration. These correlations were reported in Table 16.

Table 14
Eye-Movement Indices in Terms of Duration

Means							
Scene	I.Q.	N	NOM	MIN	SMALL	LARGE	SACCADE
15	HI	5	.46	.39	.03	.01	.05
15	LO	4	.27	.53	.13	.02	.03
26	HI	5	.47	.30	.04	.02	.06
26	MID	5	.46	.41	.02	.002	.04
26	LO	4	.28	.53	.06	.01	.05

Standard Deviations							
Scene	I.Q.	N	NOM	MIN	SMALL	LARGE	SACCADE
15	HIGH	5	.145	.155	.009	.007	.022
15	LOW	4	.046	.036	.097	.013	.010
26	HIGH	5	0.010	0.010	0.032	0.014	0.023
26	MID	5	.11	.32	.010	.005	.024
26	LOW	4	.022	.011	.014	.00	.026

Table 15
Eye-Movement Indices in Terms of Occurrence

Means							
Scene	I.Q.	N	NOM	MIN	SMALL	LARGE	SACCADE
15	HI	5	.33	.32	.07	.03	.18
15	LO	4	.22	.37	.16	.07	.10
26	HI	5	.30	.26	.10	.02	.23
26	MID	5	.32	.32	.06	.01	.21
26	LO	4	.21	.34	.12	.04	.17

Standard Deviations							
Scene	I.Q.	N	NOM	MIN	SMALL	LARGE	SACCADE
15	HIGH	5	.060	.080	.358	.167	.802
15	LOW	4	.0426	.022	.052	.031	.025
26	HIGH	5	0.118	0.067	.049	0.025	0.109
26	MID	5	.027	.163	.035	.063	.062
26	LOW	4	.04	.033	.153	.043	.072

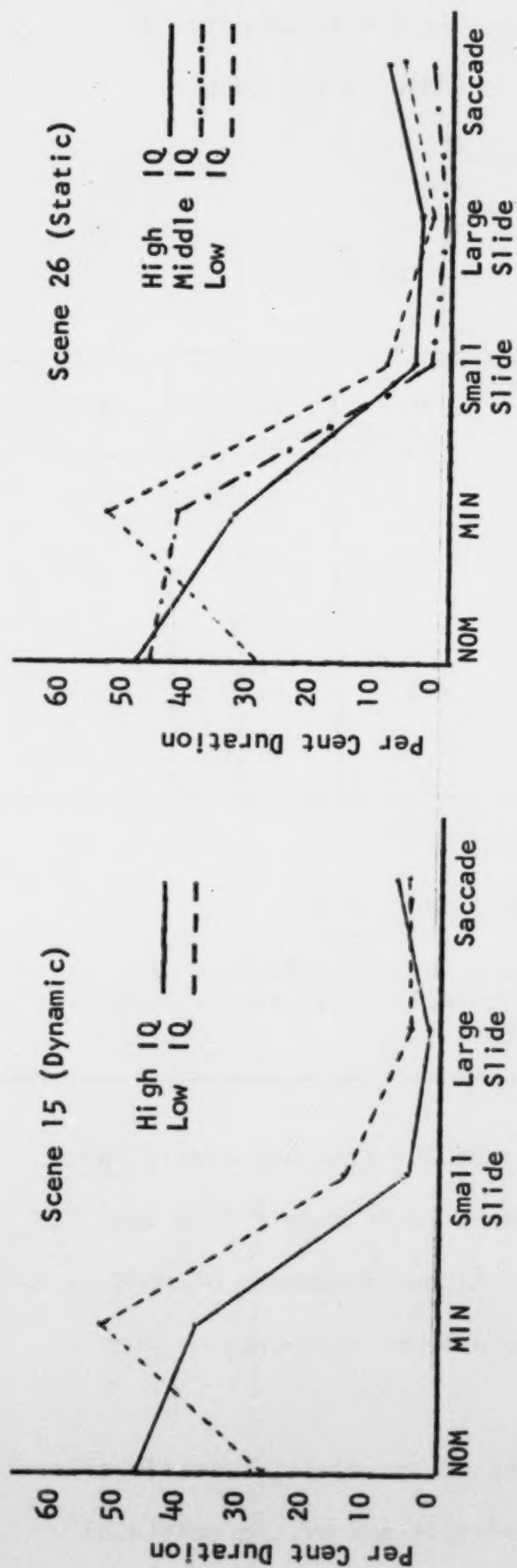


Figure 27: Distributions of Eye Movements (Duration)

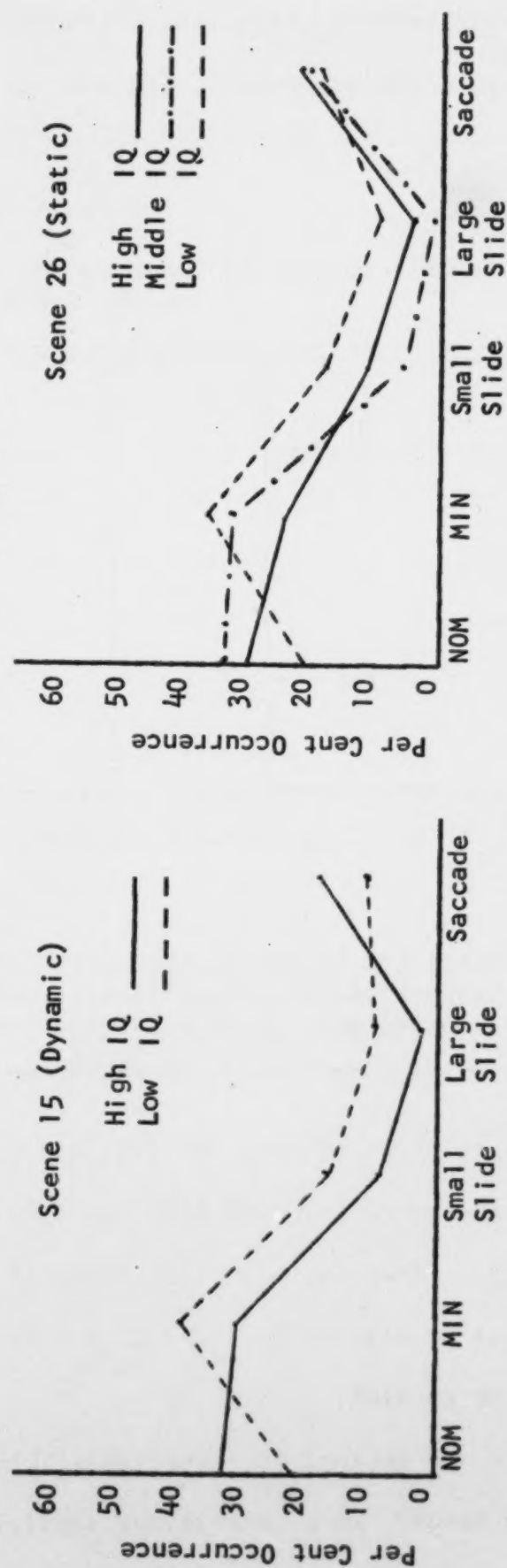


Figure 28: Distributions of Eye Movements (Occurrence)

It should be noted here that these correlations were only computed on Scene 26 where a middle I.Q. group was also included in the sample.

Table 16
Correlations of Eye-Movement Indices to CTMM Measures
(N=14; Scene=26)

	NOM	MIN	SMALL SLIDES	LARGE SLIDES	SACCADES
TOTAL I.Q.	.61*	-.70**	-.17	0.00	.25
TOTAL M.A.	.57*	-.71**	-.17	0.00	.31
NON-LANGUAGE	.66**	-.79**	-.21	0.00	.13
SPATIAL RELATIONS	.73**	-.75**	-.33	0.00	.15
r_s^1	.702**	-.672**	-.241	0.000	.119

Significance Levels: *Less Than 0.05

**Less Than 0.01

¹ Since the scores on the Spatial Relations test are given to the nearest tenth percentile, Spearman rank correlations are presented as being more descriptive than the Pearson r.

The correlation of NOMS and I.Q. was found to be positive and significant, while the correlation of MINS and I.Q. was found to be significant but negative. That is, high I.Q. subjects have a higher frequency of NOMS relative to MINS while low I.Q. subjects have a lower frequency of NOMS relative to MINS.

It was decided to investigate this aspect of the distribution further. That a larger, more generalized subdivision of this end of the continuum

which would include both NOMS and MINS may define a single general aspect of eye movement from a perceptual viewpoint is a possibility indicated on purely theoretical grounds.

Compound Eye-Movement Indices

It was suspected at this point that a more generalized subdivision should indicate a relation between behavior and intelligence. For the purpose of demonstrating this characteristic of the distributions quantitatively and statistically, two new "compound indices" were defined. The first of these is the ratio NOMS to MINS, hereafter referred to as N/M. It was anticipated that this ratio would be a good indicator of the relative frequencies of NOMS and MINS and would reflect their apparent strong relation to intelligence. Another obvious possibility for a measure of this characteristic of the frequencies of NOMS and MINS is a compound index defined as the difference NOMS-MINS, hereafter referred to as N-M.

Correlation coefficients (Pearson r) for these two new indices against measures from the California Test of Mental Maturity are given in Table 19. The relationship of N/M to I.Q. was somewhat curvilinear; accordingly, it was noted that a logarithmic distribution might provide a better fit. The correlations of the criterion measures to the log N/M are also presented in the table.

In order to determine if the differences in eye-movement indices were evoked primarily by intelligence characteristics or the nature of the stimulus material, probabilities of differences for duration were calculated using the Mann-Whitney U Test. These probabilities are reported in Table 20. It should be noted that this test is affected by ties, and when the

Table 17

Compound Indices in Terms of Duration

SCENE	I.Q.	N	N/M		N-M	
			Mean	S.D.	Mean	S.D.
15	HI	5	1.53	.422	.074	.293
15	LO	4	.52	.117	-.042	.219
26	HI	5	1.77	.98	.162	.136
26	MID	5	1.21	.57	.046	.202
26	LO	4	.55	.011	-.255	.334

Table 18

Compound Indices in Terms of Occurrence

SCENE	I.Q.	N	N/M		N-M	
			Mean	S.D.	Mean	S.D.
15	HI	5	1.13	.501	.01	.137
15	LO	4	.59	.55	-.157	.078
26	HI	5	1.20	.094	.122	.122
26	MID	5	1.05	.501	.113	.113
26	LO	4	.61	.097	.029	.029

Table 19

Correlations of Compound Indices to CTMM Measures
(N=14; Scene=26)

	N/M	N-M	log(N/M)
TOTAL I.Q.	.65*	.70**	.76**
TOTAL M.A.	.60*	.69**	.68**
NON-LANGUAGE	.67**	.77**	.76**
SPATIAL RELATIONS	.66**	.85**	.78**
r_s^1	.857**	.834**	.857**

Significance Levels: *Less Than 0.05

**Less Than 0.01

¹ Since the scores on the Spatial Relations test are given to the nearest tenth percentile, Spearman rank correlations are presented as being more descriptive than the Pearson r.

Table 20

Probabilities of Differences (Duration)

SCENE	I.Q.	N	NOM	MIN	SMALL	LARGE	SACCADE
15	HI-LO	9	.032	.11	.016	---	.064
26	HI-LO	9	.032	.016	.28	---	.56
15-26	HI	5	1.00	.42	.10	.10	.10
15-26	LO	4	.65	.89	.20	.20	.34

number of ties is large an insignificant or a significant U may result depending on where the ties fall.

On the static scene (Scene 26) significant differences between high and low I.Q.'s were obtained for NOMS, MINS, and N/M. For LARGE SLIDES there were too many ties to calculate a meaningful U. In the dynamic scene (Scene 15) significant differences resulted for NOMS, SMALL SLIDES, and SACCADES.

Since the N was small and the number of ties for SACCADES and SLIDES were fairly large, it seemed more reasonable to examine this table in light of both scenes taken together. When this was done, NOMS, MINS, and N/M were the best discriminators.

Between scene differences were calculated for both high and low I.Q. groups. No category yielded significant differences. Here though, NOMS, MINS, and N/M were the categories in which the differences were most due to chance.

Similar data was calculated for occurrence and is presented in Table 21. This data does not lend itself to as meaningful an explanation.

Table 21
Probabilities of Differences (Occurrence)

SCENE	I.Q.	N	NOM	MIN	SMALL	LARGE	SACCADE
15	HI-LO	9	.016	.56	.032	---	---
26	HI-LO	9	.29	.12	.56	---	.56
15-26	HI	5	.84	.42	.22	.42	.84
15-26	LO	4	.69	.20	.20	.20	.20

The only striking thing seems to be that the ratio N/M yields significant differences between high and low IQ subjects on the same scene but does not produce similar significance when comparing between scenes.

Spatial and Temporal Dimensions

Using the data from Table 14 and 15 (duration and occurrence) it was possible to calculate the mean duration of the various eye-movement indices. This data is presented in Table 22 as both mean number of frames and mean number of seconds. Using the operational definitions, the minimum and maximum extent for these eye movements were estimated. Knowing, therefore, the mean duration and the extent, it is possible to approximate the range of velocities for our indices. All of this data was done only for Scene 26. On Scene 15 the mean duration in both frames and seconds alone were calculated. The data for the mean duration of the various indices is represented as a graphic distribution in Figure 29.

The general classification including both NOMS and MINS was related to individual subject characteristics. It was hypothesized that fluctuations of indices in this end of the continuum should also be a function of time. The compound index, N/M , was selected and this was plotted for Scene 15 at two-second intervals. Similar data were plotted for the high IQ group only on Scene 26. The data are presented in Figures 31 and 32 respectively. The sum of NOMS and MINS ($N + M$) was plotted for Scene 15, for both the high and the low IQ groups. This is presented in Figure 30.

Table 22
Duration and Velocity of Eye Movements

Scene 26					
Eye Movements	Mean Duration		Extent (deg.)		Velocity (range) Deg/Sec.
	Frames	Seconds	Min.	Max.	
NON	5.52	0.294	0	25'	0-1°25'
RIN	4.81	0.256	17'	1.5°	1°6'-5.8°
Small Slide	1.66	0.088	1.5°	5°	17.0°-56.8°
Large Slide	1.00	0.053	4°	7°	75.5°-132.1°
Saccade	0.93	0.049	1.5°	10°	30.6°-204.1°

18.75± 0.05 fps: "On" phase = 0.03559 secs.
 "Off" phase = 0.01771
 Total = 0.05330 secs.

Scene 15 (Mean Duration Only)

Eye Movements	Mean Duration	
	Frames	Seconds
NON	4.34	0.231
RIN	4.24	0.226
Small Slide	1.74	0.093
Large Slide	0.81	0.043
Saccade	0.86	0.046

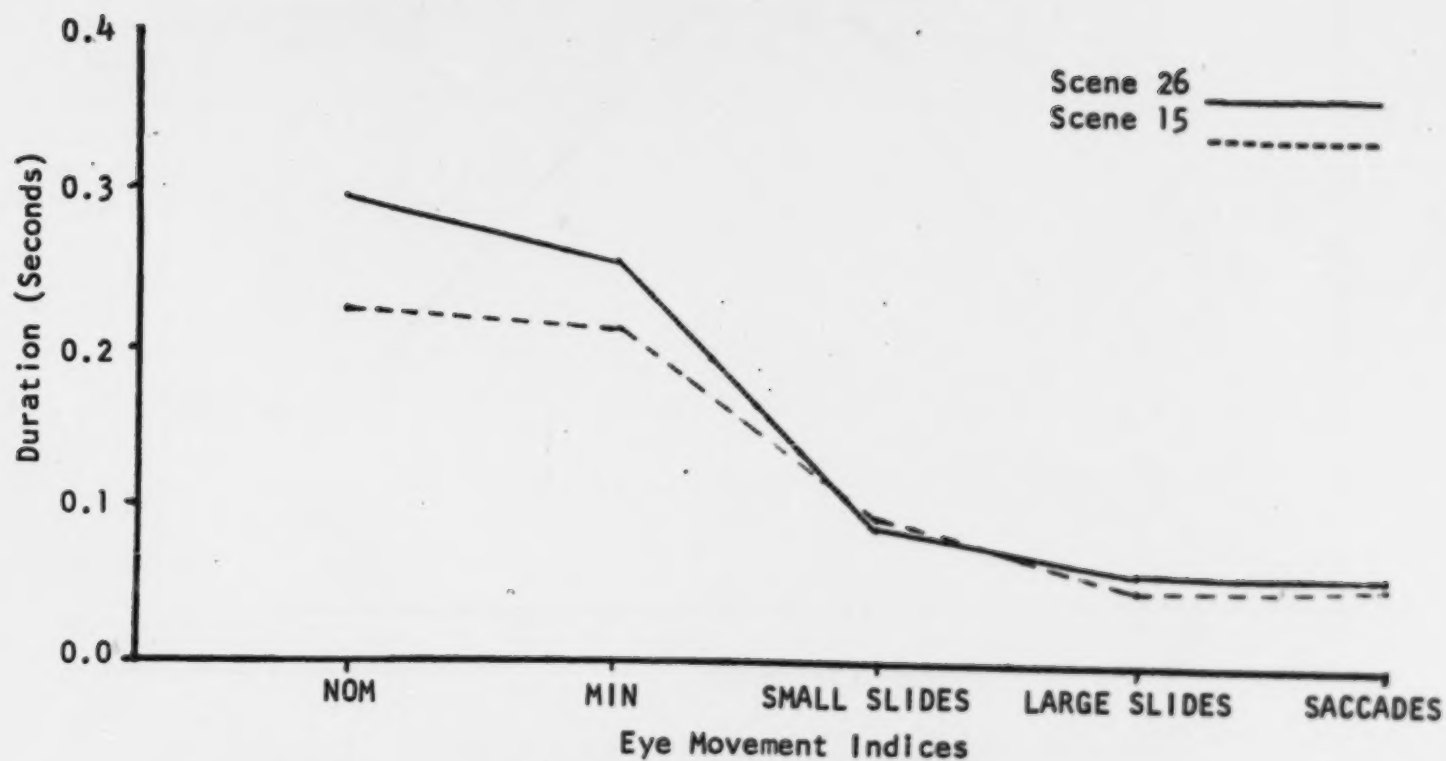


Figure 29: Mean Duration of Eye Movements

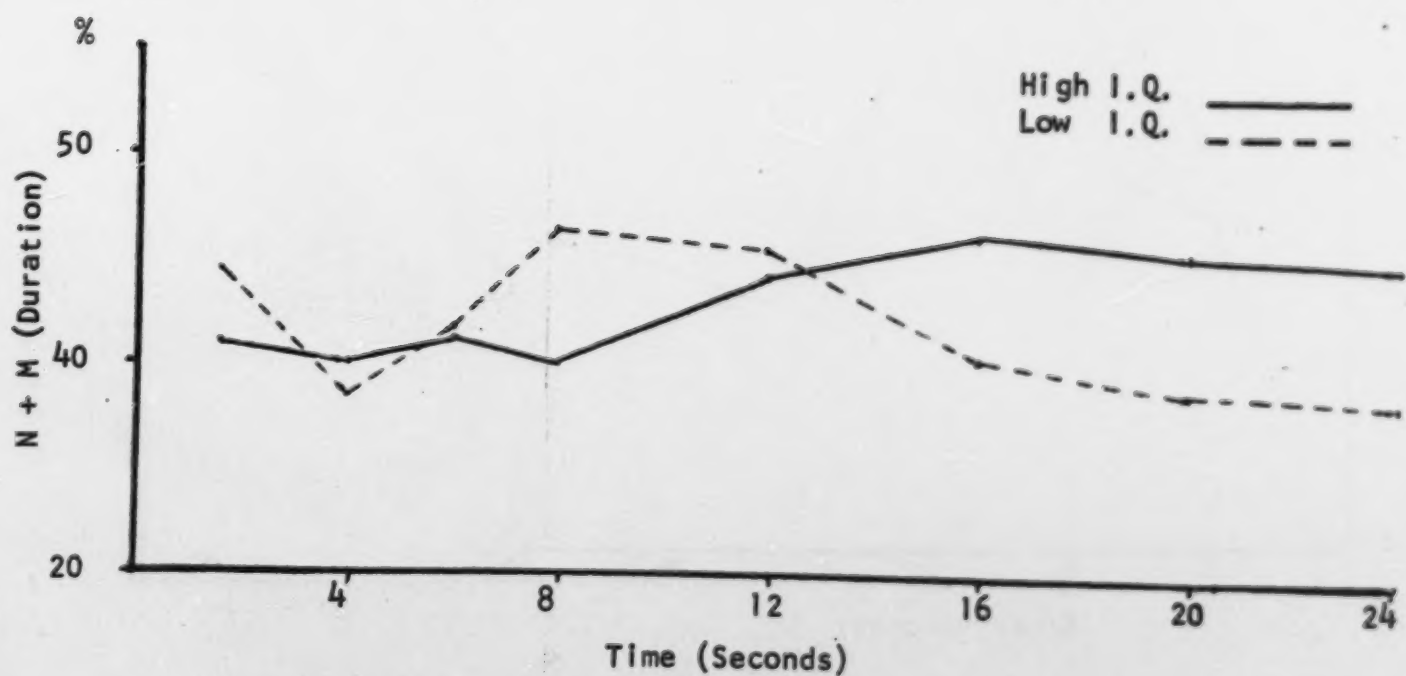


Figure 30: Change in N + M With Time (Scene 15)

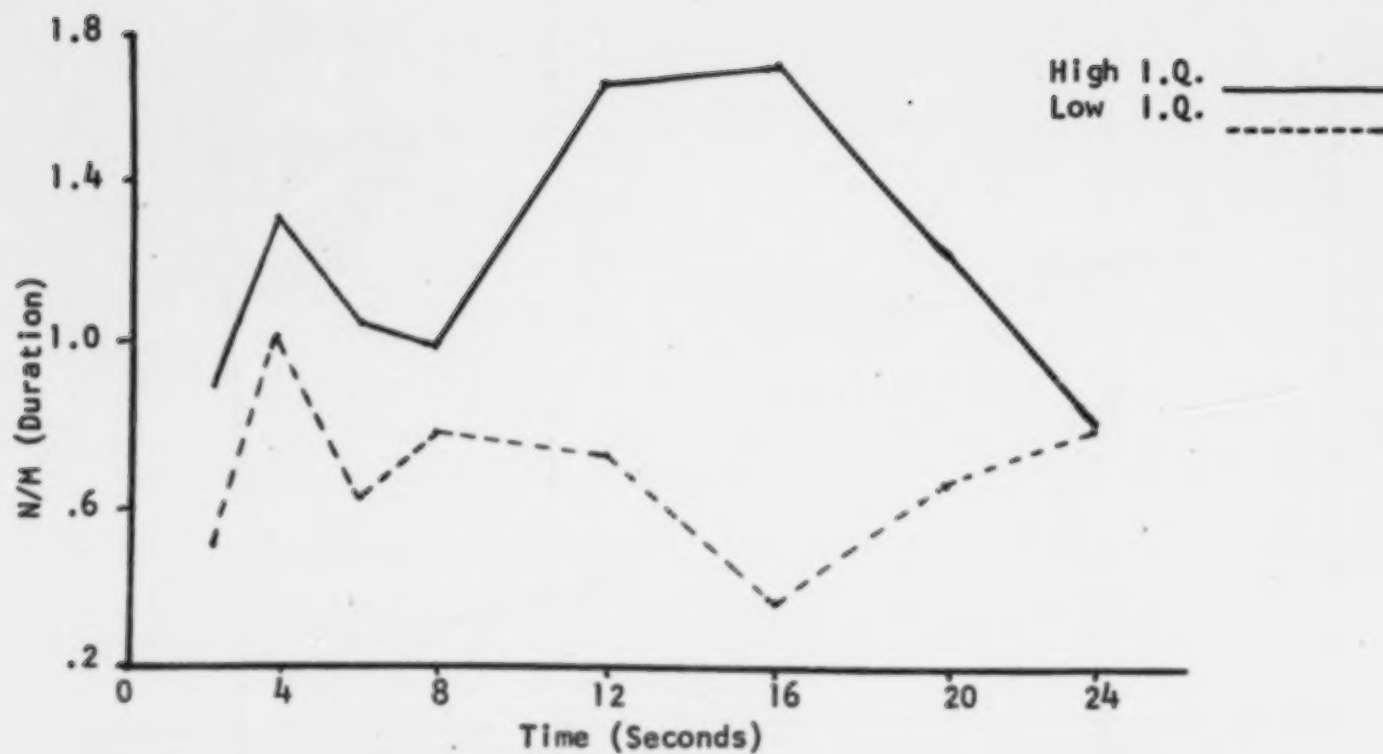


Figure 31: Change in N/M With Time (Scene 15)

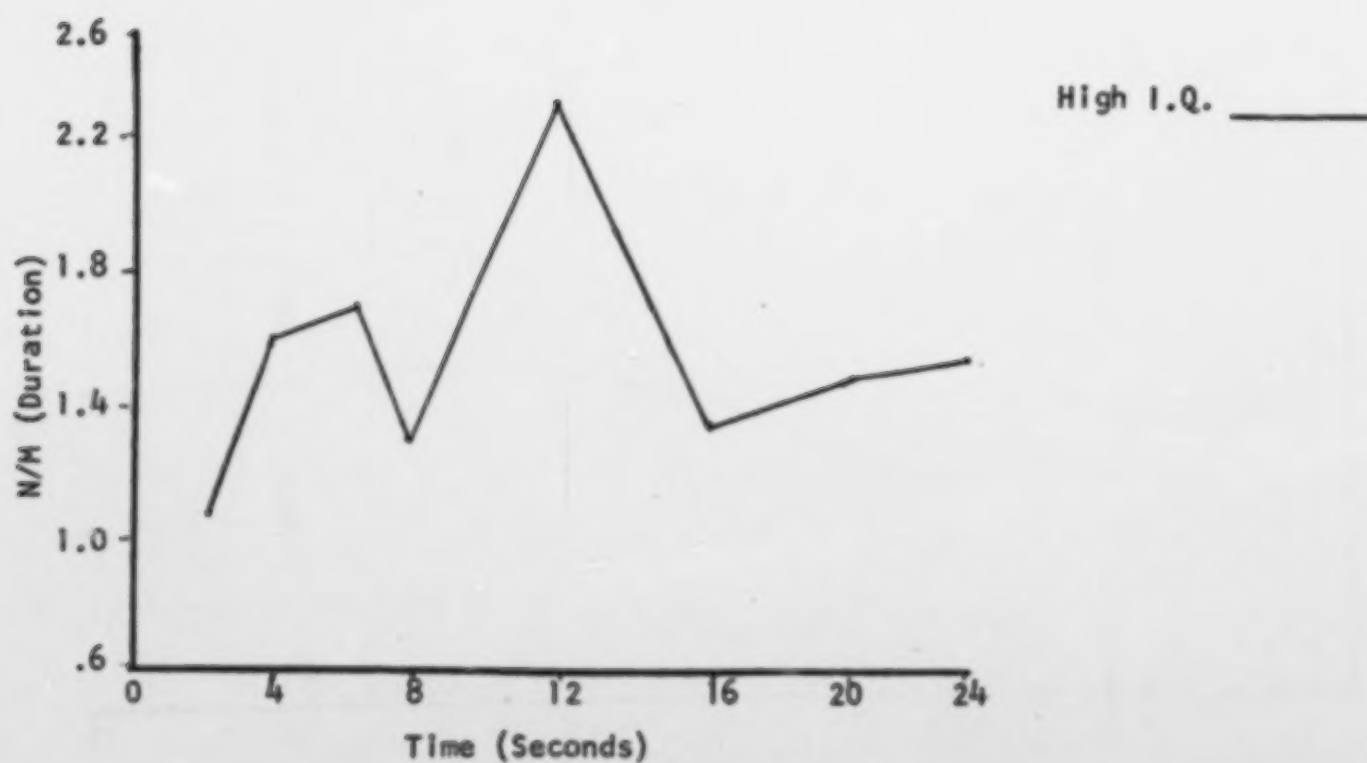


Figure 32: Change in N/M With Time (Scene 26)

Discussion of Data

An early, but most important finding of this study was that the identified eye movements fell on a continuum rather than into two extreme groups, i.e., fixations and saccades. Indeed, it became important to define at least four indices. These are: NO OBSERVABLE MOVEMENT, MINI-MOVEMENT, SLIDES, and SACCADES.

An examination of the correlations presented in Table 16 reveals that of the simple indices only NOMS and MINS correlate significantly with IQ. These indices form the peak at the lower end of the continuum and reflect, in large part, the fixations of many other researchers.

When we examine the graphic distributions of the eye-movement indices, it is immediately apparent that it is not only the relation of NOMS or MINS to IQ which is relevant but that the change in relative proportions between these two indices also seems to be very meaningful. Hence, the possible addition of a compound index which consists of both NOMS and MINS is indicated. The correlations of compound indices to the CTMM measures (Table 19) reveal that all of the indices (N/M , $\log N/M$, $N-M$) correlated with each of the CTMM measures at better than the .05 level. $N-M$ and $\log N/M$, correlated with all of the measures at better than the .01 level. In our operational terms, it is the relative proportions of NOMS and MINIMOVEMENTS which is the most meaningful when relating to intelligence. Due to the fact that the spatial relations sub-test yields the highest correlation, it may be hypothesized that this end of the continuum which includes both NOMS and MINS has an important relationship to perception.

It should be stressed that these correlations were derived from a small sample of subjects ($N=14$) utilizing the eye-movement data of a single

scene. Nevertheless, when the data were checked by plotting a frequency distribution for the high and low IQ groups ($N = 9$) of this same sample for another scene, similar qualitative characteristics were exhibited. It may be concluded, therefore, that the existence of an eye-movement index, which is correlated with the IQ of the subjects, is indicated. This tentative assertion should now be tested by replication with a larger sample, and the degree to which these new indices are independent of scene structure should be analyzed with a wider range of visual materials.

The existence of a second peak in the frequency distribution of eye-movement indices at the saccadic end of the continuum is also apparent. The relatively low correlation of the saccades with respect to IQ is not necessarily surprising in spite of the fact that reading studies have found this index to be highly significant. It must be remembered that the structure of the field and the visual task in reading studies are fundamentally different from that of a dynamic bi-dimensional field such as a telelesson.

Studies proposing that some movement is physiologically necessary have already been discussed. We can expect, furthermore, that a measure discriminating those individuals better able to perceive and maximize the perception of their environment, would also be related to measures of intelligence. Using the operational definitions and the previous assumptions, it was found that the lower IQ groups evidenced more MINS and more SMALL SLIDES. The higher IQ group, on the other hand, evidenced more NOMS, less MINS, and less SMALL SLIDES than the lower IQ group. In fact, NOMS do correlate positively and MINS negatively with IQ. Both of these correlations were significant at better than the .05 level. The correlation

of SMALL SLIDES with IQ was negative and not significant.

The probabilities of the differences, for duration and occurrence, between the high and low IQ groups and between scenes are presented in Tables 20 and 21. In interpreting these data for duration we would conclude that within a scene, NOMS, MINS, and N/M show the highest relation to intelligence, and between scenes the differences in these categories are largely due to chance. Similarly, for occurrence, we may conclude that the ratio of N/M is an important discriminator between IQ groups and is not affected significantly by different scenes. In other words, these types of eye movements are correlated more with the intellectual ability of the observer than with the visual material.

Besides being related to individual subject characteristics such as intelligence it was hypothesized that fluctuations of indices in this end of the continuum would also be a function of time. The compound indices N/M and N + M were plotted at two-second intervals for Scene 15. The data are presented in Figure 31 and Figure 30. It is noticed that the sum N + M is relatively stable.

Since this approach was developed in the late stages of data analysis, as complete an investigation as would be desirable was not possible; yet, the following observations are suggested: (1) The temporal pattern seems to be divided into two phases. During Phase One, both the high and low IQ's show parallel patterns. This may be similar to the "orientation phase" of other researchers. This phase is longer for the low IQ group. (2) At no time does the high IQ group show a lower ratio of N/M than the low IQ group. (3) A "leveling off" in the curve seems to be reached at the end of the scene. This is somewhat confirmed by similar data plotted for only high IQ's on Scene 26 (Figure 32).

CHAPTER V

IMPLICATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

Since there had been no previous studies of eye movements in tele-viewing reported in the literature, the present research was, of necessity, exploratory. As a consequence few definitive conclusions may be drawn (see Chapter IV). Nevertheless, tentative as they are, the findings clearly have many implications for various groups: perception and learning theorists, instructional television producers, teachers, and other researchers. The major findings, it will be recalled, included the following:

- (1) There was a marked clustering of the eye marker on certain areas of the visual field, i.e., there are some areas within a telelesson which subjects find more compelling than others. The most definite tendency of subjects was to focus on the narrator's face. The narrator's hands, when holding an object, and areas discussed by the narrator were also compelling.
- (2) The eye marker often changed in focus. This change, termed "blooming" because its effect is to cause the eye marker to enlarge, is believed to be related to attention. There is some reason to believe that some of the blooming effects are produced by visual-aural conflict, although this conclusion is highly tentative.
- (3) Eye movements did not fall into the two classic types--fixations and saccades--that other eye-movement research would lead one to expect. Rather, a continuum of movement was observed. The existence of this continuum together with the fact that very small micro-nystagmus types of movements have been reported in other studies, suggests that the eyes are constantly moving.

- (4) The eye movements tended to be limited to a relatively small central area when the scene became dynamically very complex. An initial surmise that this cessation in extensive movement might be a form of coping in which peripheral vision is used was not well supported by the data, leading to the tentative conclusion that this behavior was in fact a "surrender" in the face of a demanding visual task.
- (5) Pattern differences relating to intelligence were identified. Two forms of relationship were noted:
 - (a) derived pattern indices and combinations of these indices, e.g., N/M, were correlated with IQ data, and
 - (b) patterns of the basic indices, e.g., the N/M ratio, were found to change differentially over time in the low and high intelligence groups.

The following implications, although based on the data of this pilot study, are clearly extrapolations from the experimental findings. While they seem reasonable and useful at this point in time, subsequent research may support or refute them.

IMPLICATIONS FOR TEACHERS

Two major implications may be derived for teachers. First, there is the matter of the "viewability" of the materials to which she exposes her classes. The term "viewability" should be taken as directly analagous to "readability"; both terms refer to a characteristic of visual material and are concerned with the "understandability" of that material. It is clear that not all materials are equally "viewable." The present study did not attempt to define an index which a teacher may easily apply; the operational definition of "viewability" remains to be determined. Nevertheless, it is apparent that such a concept is appropriate and the teacher is well advised to keep it in mind as she makes decisions about what her class should view.

Second, there is the matter of individual differences in children. Large inter-subject variability was found both between and within the high and low intelligence groups. These differences are reflected in the high correlations of the eye-movement indices with intelligence, in the differences in the number of lost eye markers, and in the temporal patterns or changes over time for the two groups. The data suggest that the patterns of eye movements are more related to individual subject characteristics than to differences in the visual material. A teacher cannot expect all children in her classroom to view a telelesson and without any assistance obtain all the information therein. Quite often the dull children may not even be watching the set at all, or when they do watch the set, may take a longer time to absorb the material.

The concepts of good teaching practiced in many aspects of the classroom work should be carried over to the area of television. Teachers must work with the children to discover what concepts they have misunderstood or missed entirely. Then, children should be given individual attention and reinforcement through other activities or additional materials. It may be that some children will benefit more through other activities while the rest of the class is viewing television. However, more research will be needed before a definite conclusion can be made on this point. Several years ago educators recognized that there were many differences among children of a given age or grade in ability to learn and in interests. This led to a new emphasis on the individual child. Educators should remember that these differences also exist for children viewing television.

IMPLICATIONS FOR PRODUCERS

Three implications emerge from the study which are of primary interest to television producers. These are concerned with what is put into the telelesson in the first place, with how the telelesson might be field-tested, and with a way in which exposure for particular scene might be determined.

One of the most marked findings of the study was that subjects do tend to "cluster," i.e. to focus upon particular areas to the exclusion of others. Some of these preferred areas are attention centers which the producer wishes the subject to look at while others are attention distractors. It is of obvious importance to maximize attention centers and minimize attention distractors. While the present study makes only a beginning in this area several facts are apparent. First, subjects do tend to look at a narrator's face, and unless there is some special reason why a narrator needs to be on screen it is probably desirable to eliminate him entirely, especially when attention is sought on some other object. Similarly, it seems evident that the fewer the number of distractors or potential distractors which appear in a scene, the more likely is the subject to view that element which the producer desires him to view. Second, it is apparent that the narrator can direct attention through his actions or through his narration. The narrator's hands are important cues to the subject, who will often look at what that narrator is reaching for before he picks it up. Narration itself serves as an effective director. Thus in the scene in which the word "carbohydrates" is superimposed, subjects spent a great deal more time looking at the first part of the word--"carbohy"--than upon the last part--"drates"--because this is the part the

narrator emphasized. Careful attention to such cues by the producer can lead to a more meaningful presentation. It should also be clear from the "surrender" phenomena that very busy fields or rapid scene changes are probably not desirable, at least as a general rule.

The possibility of field testing is considerably enhanced by the techniques used in this study. The apparatus itself affords a reasonably convenient way to determine what subjects do look at--whether, for example, clustering is occurring in relation to those phenomena which the producer seeks to emphasize. If important areas are not being observed, or if extraneous materials happen to work too well as distractors, this effect can be detected and corrected. Occurrence of "surrender" may be interpreted as an indication that the material is too complex, as can excessive leaving the field (disappearing eye marker), blinking, or other avoidance phenomena. There is also the possibility that the blooming phenomenon may be refined sufficiently to serve as an attention and/or conflict indicator, although this use is probably some time off from a practical point of view.

Finally, there is the interesting possibility that the observed changes in eye-movement indices with time may in fact be used as an indicator of the time necessary to expose a scene for learning. These indices, e.g., N/M, change for both high and low intelligence groups over time; as the scene continues on the screen the proportion of NOHS to MINS changes. If it is a safe assumption that changes in learning, or concentration upon the subject matter, are reflected by corresponding changes in the eye-movement indices, then the changes in these indices would be useful to determine the appropriate pacing in a presentation and the amount of time

necessary to expose a scene for learning. If this time is determined for low intelligence subjects, say, the time of maximum exposure of the scene is also determined; for if the scene is exposed for a longer time, very little additional learning will occur for any subject.

IMPLICATIONS FOR PERCEPTION AND LEARNING THEORISTS

Eye-movement studies in the past have tended to support the idea that the eyes tend to move in sharp saccades, during which very little perception occurs and then tend to rest in fixations, during which almost all perception, and therefore learning, occurs. Observed variations from this pattern were usually taken to be instrumental unreliabilities, neuromotor instabilities, or pathological conditions not normally noted.

The present study throws these earlier conclusions into considerable doubt. There is first of all the fact that a continuum of movement, of which fixations and saccades might be thought to be extremes, needed to be defined to handle all of the phenomena encountered. The existence of minimovements other than random instabilities or nystagmus type movements can no longer be doubted, and other types of movements here called slides also do not fit the classic pattern.

Of more importance is the fact that these movements seem to be related to intelligence. The correlations reported here are astonishingly large--large enough to be used effectively as a physiological measure of IQ. Moreover, learning seems to be a function of small movements rather than simply of fixations; indeed, the amount of learning probably is directly related to increments and decrements in the W/N ratio. This seems

to suggest that the earlier theory that most perception and hence most learning occurs during fixations is probably false.

The study clearly raises more questions than it answers; indeed the answers may not be possible from studies of this type. However the findings may be interpreted, the need for further study and theoretical reorientation is indicated.

IMPLICATIONS FOR OTHER RESEARCHERS

The implications noted in the preceding sections are, of course, also implications for further research in those areas. Two other kinds of comments may be made here: those dealing with the apparatus of the study, and those dealing more particularly with further studies along the same lines as that pursued here.

Certainly one of the most useful outcomes of the study is the development of a tolerably reliable apparatus for the study of eye movements in bi-dimensional fields. This apparatus has many applications in areas other than instructional television. Responses to any bi-dimensional field--whether it is the pilot scanning instruments in his cockpit, the housewife "reading the shelves" as she makes her decision in the supermarket, the automobile driver responding to cues in the road, the deaf child viewing captioned films, and a host of others--may be permanently recorded by the present method with suitable variations. Permanent records may be made and analyzed without the computational manipulations required by many of the commonly used previous methods.

The apparatus is, of course, not as reliable as might be desired. This is especially true because many of the phenomena of interest--

blooming, clustering, minimovements, and the like--are difficult to read accurately when the system may get as much as a degree or two out of calibration. Some of these phenomena are themselves of this same order; the possibility of confounding is obvious. Strenuous efforts should therefore be made to improve the apparatus, or failing that, to devise other methods of stimulus exposure (e.g., a very large screen?) to obviate these problems. Apparatus modifications should be aimed at reducing errors in the eye-marker system and improving the stability of the system.

Another apparatus problem of considerable dimensions is that of data readout. The "eyeballing" techniques of the present study simply do not suffice, if for no other reason than that they are too slow and, in the face of the mass of data produced by the system, much too cumbersome. Automatic systems must be devised, which depend either upon optical scanning techniques or upon interpretations of the eye-marker position from the television signal itself. This problem is not unsolvable; its solution would mean to this field roughly what the computer means for problems of great computational complexity.

Moving to the matter of further substantive research in the area, it is clear that a whole series of studies need to be undertaken to probe further the findings and implications of this pilot effort. A further investigation should be made of the nature and function of the various eye-movement indices that have been developed. The relationship of these indices to different stimulus materials, to subject characteristics, and to age levels should be investigated. The hypothesis that viewing patterns are more closely related to subject characteristics than to the

characteristics of stimulus materials needs further study, and with a much larger sample. Situational factors do also affect eye movements, of course, and should receive attention. A few of these are:

- (1) the instructions given the subject;
- (2) the physical setting including size of viewing screen and its distance from the viewer, light level in the room, and noise and other distractors;
- (3) the "viewability" of the lesson material. This concept, analagous to readability," refers to type of content, method of presentation, difficulty of concepts, and other similar factors.

All of the findings of the present study have necessarily been highly tentative. The work will be further refined and extended over the next two years. At this stage all that can be asserted with certainty is that a powerful new tool for the study of educational television has been identified and sufficiently tested to indicate its utility. There can be no doubt that further work in this area and using these techniques will be highly rewarding.

APPENDIX A

RATING FORM FOR TELELESSONS

I. GENERAL

Title _____	Series _____	Length _____	Rating: _____ Excell. _____ Good _____ Avg. _____ Fair _____ Poor
Age Level (stated) _____	Accomplished Age Level _____		
Lesson Purpose _____			
Achievement of Purpose: Excell. _____ Good _____ Avg. _____ Fair _____ Poor _____			

Comment: _____

The auditory explains the visual material. Never _____ Sometimes _____ Always _____

The visual material explains itself or stands alone. Never _____ Sometimes _____ Always _____

The auditory discusses the visual material plus other things not shown in film. Never _____ Sometimes _____ Always _____

Testability of material: Excell. _____ Good _____ Avg. _____ Fair _____ Poor _____

II. LESSON CONTENT

_____ Factual _____ Principles _____ Problem Solving _____ Values, Attitudes
 _____ Skills _____ Combination (explain) _____
 _____ Other (explain) _____

III. METHOD OF PRESENTATION

_____ Lecture _____ Demonstration _____ Discussion _____ Story Form
 _____ Combination (explain) _____
 _____ Other (explain) _____

IV. TALENT

Description (teacher, children, etc.) _____

Quality: Excell. ___ Good ___ Avg. ___ Fair ___ Poor ___

Comment _____

V. TEACHING AIDS

___ Animation ___ Apparatus ___ Chalk Boards ___ Charts, Graphs ___ Example obj.

___ Filmclips ___ Flipcards ___ Maps ___ Models, Miniatures ___ Photos ___ Supers

___ Unusual (explain) _____

VI. PRODUCTION TECHNIQUES

___ Action (movement of talent, props) ___ Camera Movement ___ Zooming

Background: ___ Detailed ___ Plain Scene Changes: ___ Abrupt ___ Gradual

Varied Scene Duration ___ Narration ___ Dialogue ___

VII. EXPERIMENTAL REQUIREMENTS (comment on back of sheet on each item if necessary)

___ Some material is presented so that a definite sequence of eye movements is required.

___ There is a complex foreground which requires that the learner sort out and synthesize.

___ Some material requires that the learner synthesize several scenes in order to comprehend.

___ Some material requires that the learner draw conclusions not stated for him.

___ Other (explain) _____

APPENDIX B

SCENARIO

The Midwest Program on Airborne Television Instruction

THE ADVENTURE OF SCIENCE (1962)

TELECAST 7: HEALTH HABITS

(Edited Version of Original Kinescope)

With an Appended Segment:

THE WEST SIDE STORY Sequence from a

Telecast (1962) in the Series THE LIVELY ONES

Produced by the National Broadcasting Company

This Scenario divides the television lesson into scenes and sub-scenes on the basis of the visual material presented.

The left column gives a transcription of the audio track of the kinescope film, while the right column gives brief descriptions of the associated visual material.

The duration, in seconds, is indicated at the beginning of each scene.

SCENE: 1 SPECIAL LEADER MATERIAL AND TITLES
TIME: 24

- | | | |
|-----|--|--|
| 1.1 | (No audio) | Television "flip-flop" frames to enhance the 'Television Program' simulation when this kinescope film is projected through the TV set mock-up used in the experiment |
| 1.2 | (No audio) | (MPATI emblem) |
| 1.3 | The Mid-west Program on Airborne Television Instruction presents The Adventure of Science, a series in science for elementary grades, taught by... | THE ADVENTURE OF SCIENCE
(super) |
| 1.4 | John Burns. Today's telecast, number 7. | JOHN BURNS (super) |
-

SCENE: 2 NARRATOR WASHES AND DRIES HANDS;
TIME: 57 PICKS UP PETRI DISH

- | | | |
|-----|---|--|
| 2.1 | (Faint sound of hand washing) | (close up of hand washing) |
| 2.2 | (Faint sound of hand washing) | HEALTH HABITS (super)
(continues hand washing) |
| 2.3 | (Faint sound of hand washing) | (continues hand washing) |
| 2.4 | You know why you do this? Well you may well do this because your mother or father tell you to do it; that's a good reason... | (camera moves out, continues hand washing) |
| 2.5 | too. But perhaps there's a better reason, or at least a more scientific reason by first pointing out a little experiment or demonstration -- as soon as I dry my hands. | (dries hands and walks over to table) |
| 2.6 | On this plate, which may look clear to you, actually is a gelatin. Now this gelatin was... | (talking from behind table; picks up a petri dish) |
-

SCENE: 3 CLOSE UP SHOT OF NARRATOR HOLDING PETRI DISH
TIME: 9 WITH CLEAR GELATIN

- | | |
|-----|----------------------------------|
| 3.1 | prepared in a laboratory. As you |
|-----|----------------------------------|

can see, you can look right through it. It doesn't appear to have anything in it. But it has. Well, there is food there. (close up of petri dish)

SCENE: 4 NARRATOR STANDING BEHIND TABLE: DISCUSSES
TIME: 62 PETRI DISH; PICKS UP GELATIN PACKAGE IN
PREPARATION OF DEMONSTRATION OF MAKING
GELATIN

- 4.1 Food for what? (puts aside petri dish)
- 4.2 We know when you wash your hands sometimes they're so dirty that you can see the dirt come off. But sometimes there are things there that you cannot see. (talking from behind table)
- 4.3 But we can see them by using a plate, such as this. (picks up petri dish briefly)
- 4.4 Now you may not have plates like this, but you can make a food for which these tiny organisms will grow. These organisms are so small, that you cannot see them. So they're called microbes or microorganisms. You may hear them referred to as bacteria; some of them are, or as germs. But at any rate each of these cause, or may cause, disease. Some do not. These tiny microbes or microorganisms. Now how can you make... (talking from behind table)
- 4.5 this gelatin? (holds petri dish briefly)
- 4.6 And let me repeat: the word is gelatin. (continues talking)
- 4.7 Well you can purchase gelatin at the store, and it usually comes in little containers, little packages such as this. Tear it off, ... (picks up gelatin package and tears open)

SCENE: 5 CLOSE-UP OF DISH IN WHICH NARRATOR PREPARES GELATIN
TIME: 35

- 5.1 and pour it in... (pours packet into dish)
- 5.2 the container. This, we can make,

- oh, cakes I guess. Girls you can answer the question better than I can. (talking off screen)
- 5.3 At any rate, then add about a glass of water. (pours in water)
- 5.4 And warm or hot water will work a little better,... (talking off screen)
- 5.5 and then stir it. Eventually the material, the gelatin, will disappear or go into a kind of a solution, and then... (stirs)

SCENE: 6 NARRATOR TALKING FROM BEHIND TABLE;
TIME: 56 HOLDS PETRI DISHES

- 6.1 you want to take this, while it is still liquid,... (talking from behind table)
- 6.2 and pour some of it in saucers. (sets aside dish)
- 6.3 Oh, you might make eight or ten saucers of this gelatin. (talking from behind table)
- 6.4 And this is what you can do with it then. (sets aside petri dishes)
- 6.5 Let's take our gelatin, go back, and I'll tell you what I did. Now you saw me wash my hands. I removed dirt and I have inferred,... (takes up petri dish; walks to another table; puts down petri dish)
- 6.6 or, I haven't said it at least, that I removed something else. You know people at one time weren't concerned about it because they couldn't see anything that would make them alarmed about dirty hands. But we have learned, and we first saw these tiny creatures about 300 years ago; -- we have learned that there are tiny, microscopic, creatures that may be harmful to our systems. (talking from behind table)

SCENE: 7 TRIANGLE FOR CALIBRATION PURPOSES
TIME: 10

SCENE: 8 NARRATOR TALKING FROM BEHIND TABLE;
TIME: 4 PICKS UP TWO PETRI DISHES

8.1 Now, let's get back to our gelatin. (picks up two petri dishes)
 This is the clear gelatin.

SCENE: 9 CLOSE-UP OF NARRATOR HOLDING CLEAR PETRI DISH
TIME: 27 AND PETRI DISH TOUCHED BY DIRTY FINGERS

9.1 I am going to show you a plate now
 of gelatin that I made and let stand. (holds cultured and plain
 How did I make it? I made it just petri dishes)
 as I made this, ...

9.2 and now let's put it aside because (puts aside clear petri
 it's no longer important. dish)

9.3 This I made by wiping my hand on
 the floor, and then taking my
 fingers and touching it to the (points to petri dish, and
 gelatin. It's been standing gestures to demonstrate)
 now, almost, well a little
 over a week, about eight days.

SCENE: 10 NARRATOR TALKING FROM BEHIND TABLE; PICKS UP
TIME: 31 PETRI DISH TOUCHED BY WASHED FINGERS

10.1 And you see there are many organ-
 isms. Some of these came from the
 air, but most of them came from my
 hands which touched the dirty floor (talking from behind table)
 and then the gelatin. And they
 continued to grow: these micro-
 organisms that we wouldn't see
 normally. Well why scrub our
 hands? Well this is why.

10.2 Now, at the same time, as soon as
 I prepared this one gelatin, I
 prepared another. The only thing (picks up another petri
 I did, I went down the hall and dish)
 scrubbed my hands.

SCENE: 11 CLOSE-UP OF NARRATOR HOLDING TWO CULTURED PETRI
TIME: 13 DISHES (WASHED AND UNWASHED HANDS)

11.1 Then I touched this plate. Now
 notice, you see some spots on this
 plate also, and these are caused (close-up of both petri
 by microorganisms. But there are dishes)
 not nearly as many...

11.2 as there are on this one. (taps finger on petri dish)

SCENE: 12 NARRATOR TALKING FROM BEHIND TABLE; PICKS UP
TIME: 21 PETRI DISH WITH CULTURE FROM FINGERNAIL CUTTINGS

12.1 So you see, scrubbing your hands (puts away two petri dishes)
removes some of these invisible
microorganisms.

12.2 And some of them may be harmful, (talking from behind table)
and this is why we scrub our hands.

12.3 Now I thought you might be
interested in seeing some other
plates in which we have placed (picks up another petri
other materials. In this one we dish)
placed fingernail parings.

SCENE: 13 CLOSE-UP OF NARRATOR HOLDING PETRI DISH WITH
TIME: 11 CULTURE FROM FINGERNAIL CUTTINGS

13.1 And they were dirty. Now you
notice, if you don't keep your
nails clean, this is what happens. (close-up of cultured petri
These microorganisms were made by dish)
dirty fingernail cuttings or
clippings.

SCENE: 14 TRIANGLE FOR CALIBRATION PURPOSES
TIME: 10

SCENE: 15 NARRATOR TALKING FROM BEHIND TABLE; PICKS UP
TIME: 47 TRAY WITH CLEANING AIDS; GESTURES TO DEMON-
STRATE THEIR USE

15.1 We mentioned that if we do not (puts away petri dishes)
keep...

15.2 our body clean these microorganisms
may invade it. So our skin then (talking from behind table)
becomes the first defense against
these microorganisms.

15.3 And we would hope that, well, we (picks up tray)
not only scrub our hands,...

15.4 but we would bathe, use soap, all (holds soap)
over our body, removing these
microbes.

15.5	We would scrub our fingernails;...	(holds brush)
15.6	we would use a fingernail cleaner to clean our nails,...	(holds nail file)
15.7	and we would also scrub our hair, or our head,...	(holds up bottle)
15.8	again removing the microbes that come from the air. So by using...	(talking from behind table)

SCENE: 16 CLOSE-UP PANNING SHOT OF CLEANING AIDS
TIME: 17

16.1	these aids, soap,...	(close-up of soap)
16.2	the brush with which we can scrub our nails, and the nail file,...	(pan to brush and file)
16.3	and shampoo or soap, we can remove many of the microbes from our skin,...	(pan to shampoo bottle)

SCENE: 17 NARRATOR TALKING FROM BEHIND TABLE
TIME: 38

17.1	and in this way protect...	(talking from behind table)
17.2	the systems of man.	(puts tray aside)
17.3	Well, sometimes these micro-organisms do invade our outer skin, this outer protection, and this is what happens. We are going to take a look now at some tissue, which we know is a collection of like cells, that some of these organisms have invaded. Notice, and you can probably identify where this tissue was taken from.	(continues talking from behind table)

SCENE: 18 CLOSE-UP OF STILL SHOT OF MOUTH AND TEETH (FIRST)
TIME: 18

18.1	Right away we recognize the teeth so we know it's mouth or oral tissue. You notice below the lower teeth we see some diseased tissue. Now if this is not taken care of, and it probably wasn't up to this point, then...	(close-up of still shot of mouth and teeth)
------	--	---

SCENE: 19 CLOSE-UP OF STILL SHOT OF MOUTH AND TEETH (SECOND)
TIME: 3

19.1 it may become worse, we lose teeth. (close-up of still shot of mouth and teeth)

SCENE: 20 TRIANGLE FOR CALIBRATION PURPOSES
TIME: 10

SCENE: 21 NARRATOR TALKING FROM BEHIND TABLE
TIME: 23

21.1 Let's look first at a film, an actual film now, of some microbes. In this case bacteria, and you'll see they look like a chain of beads, or a chain at least, actually attack and kill some red blood cells. You'll recognize these red blood cells, I hope, by their characteristic tire or doughnut shape. (talking from behind table)

SCENE: 22 FILM CLIP OF GROWTH OF A BACTERIUM;
TIME: 31 BACTERIUM DESTROYS RED CORPUSCLES

22.1 Let's look at that film. Now watch, that tiny chain-like object. This is the microbe, the bacteria. (film clip held still to single frame)

22.2 Now watch what happens. Watch how rapidly he grows. Now this is actual photography. Now the photography is called time lapse photography. So that we are seeing what took place in a couple of hours in just a few seconds. Notice the red corpuscle disappearing. Notice the one in the lower left corner. You'll see it... (film clip shown)

22.3 (corpuscle referred to disappears)

22.4 almost become, pop, surrounded ... (film clip continues)

SCENE: 23 NARRATOR MOVES TO ANIMATED CHART OF HUMAN BODY
TIME: 22

23.1 and then disappears. This is what

can happen when these microorganisms invade our systems. A system such as the circulatory system.

(moves to animated chart)

23.2 We've discussed the systems before and you recall the circulatory system, with its heart, veins, the arteries, the capillaries, the... (standing beside animated chart)

SCENE: 24 CLOSE-UP OF ANIMATED CHART OF HUMAN BODY
TIME: 15

24.1 red blood cells, all these important to man. All these have certain requirements and we have found that the requirements of each of these cells, are the requirements of this system, and other systems. (close-up of animated chart)

SCENE: 25 NARRATOR STANDING BESIDE ANIMATED CHART OF HUMAN BODY
TIME: 20

25.1 Now what can we do, or what does happen when our blood is invaded by bacteria such as these? Well, you recall a few lessons ago we looked at a -- or we had a close look at least -- a sketch of some red blood cells. (standing beside animated chart)

SCENE: 26 STILL SHOT OF SKETCH OF RED AND WHITE BLOOD CELLS
TIME: 31

26.1 With them we mentioned very briefly white blood cells and at that time I said that this was an unusual picture; well, now I can tell you it's unusual because you do not usually see this many white blood cells that look something like an ear here in this picture. Now where you see this many red blood cells, about eight I believe, one two, three, four, five, six, seven, eight. Right, and we see four white blood cells. Usually, we see about a thousand red blood cells for every white blood cell. (still shot of sketch of red and white blood cells)

SCENE: 27 NARRATOR MOVES FROM BESIDE ANIMATED CHART TO
TIME: 40 BEHIND TABLE

- 27.1 The fact that there are so many white blood cells here means that something has happened. Some unwanted material has entered the system. And now... (talking beside animated chart)
- 27.2 the white blood cells go to work. And we are very pleased to have some film that show just what these... (moves back to behind table)
- 27.3 white blood cells will do. The white blood cell will move, as you'll see and you'll also notice the red blood cells again, looking like discs or even tires. And watch what it does to this chain of bacteria. Watch very closely, this action is happening but it is time lapse... (talking from behind table)
-

SCENE: 28 FILM CLIP OF WHITE BLOOD CELL ENGULFING BACTERIUM
TIME: 16

- 28.1 photography. Remember it takes a little longer than what we see. Now, the white blood cell you see is going after this bacteria. It has now surrounded it and it has disappeared. You can perhaps see in the center of... (film clip shown)
-

SCENE: 29 NARRATOR TALKING FROM BEHIND TABLE
TIME: 23

- 29.1 the white blood cell, we'll see them again, we didn't get a chance to see it, or I didn't get a chance to mention it, but it's interesting to notice that in the white blood cell you can see this movement flowing, actually that's cytoplasm and the scientists would call it the streaming of the cytoplasm as it enveloped or encircled the bacteria. (talking from behind table)
-

SCENE: 30 TRIANGLE FOR CALIBRATION PURPOSES
TIME: 10

SCENE: 31
TIME: 18

31.1 Now sometimes, the white blood cells are not successful in destroying bacteria. Let's watch and see that happen. Now, again, we have to watch carefully and we'll this time see the cytoplasm as it streams,...

SCENE: 32 FILM CLIP OF WHITE BLOOD CELL ENGULFING BACTERIUM;
TIME: 85 BACTERIUM IS DISGORGED; WHITE BLOOD CELL DIES

32.1 or moves. (film clip shown)

32.2 (noticeable time shift)

32.3 Now, here we see the white blood cell and now it moves toward a chain of bacteria. A particular kind of bacteria. Notice it is beginning to envelope it and you may be able to see this movement, this streaming of the cytoplasm that I mentioned. Notice it continues to envelope or encircle this bacteria. Finally, we see we have just, oh, a kind of tail of the unwanted bacteria left.

(film clip continues)

32.4 (noticeable time shift)

32.5 Notice that the white blood cell has taken many shapes at this time. It doesn't seem to have any definite shape. Now it looks like, oh, something with a little tail sticking out. But now watch as something changes. (film clip continues)

32.6 (noticeable time shift)

32.7 Instead of the rest of this
unwanted bacteria being... (film clip continues)

32.8 taken in,... ARROW (super)

32.9 by the white blood cells, and destroyed, watch. It begins to come out, emerge, or as the scientist would say, it is disgorged. And you see the white

(film clip continues)

blood cells shatter and die.
This particular unwanted material
defeated...

32.10

(noticeable time shift)

32.11

the white blood cell.

(film clip continues)

SCENE: 33 NARRATOR TALKING FROM BEHIND TABLE; PICKS UP TRAY;
TIME: 73 PUTS TWO PIECES OF POTATO ON TRAY; PICKS UP SUGAR
PACKET

33.1

Of course in this case we would want to add, and we can add, certain medicines that will help the white blood cells destroy this unwanted bacteria. We see then if, like scrubbing ourself, cleaning ourself, we keep ourselves clean, free of these unwanted materials, but if they do enter our systems, it does not mean that we are in too much trouble. If the white blood cells destroy the unwanted bacteria, we recover; if not, we may have a sore throat, or something of this kind. Now in order for all these cells to perform these functions, to perform these functions as best they can, they need food. And we've talked about this before. We know they need oxygen and so on, and you can find out the proper kinds of food that these cells need, or your body, or the systems, because all of them are the same, have the same requirements, by reading books on diet, and so on.

(talking from behind table)

33.2

But I thought I'd mention just briefly some of the foods that we should have.

(picks up tray)

33.3

First of all, starch is important to us.

(puts two pieces of potato on tray)

33.4

And starch can be found, well, in a potato...

(picks up sugar packet)

SCENE: 34 CLOSE-UP SHOT OF TRAY WITH POTATO;
TIME: 23 NARRATOR ADDS SOME SUGAR

34.1 is one example. We need... (talking off screen)
34.2 sugar, pour some here. (pours out sugar)
34.3 These foods are called carbo... (talking off screen)
34.4 hydrates. Now carbohydrates is
a big word, but it's rather simple.
It means carbon, and you can see
the first four letters of carbon.
And then the "o" for oxygen and
"hy" for the hydrogen. Carbo... CARBOHYDRATES (super)

SCENE: 35 NARRATOR TALKING FROM BEHIND TABLE;
TIME: 12 ADDS PEANUTS TO TRAY

35.1 hydrates. Now these foods, ... (talking from behind table)
35.2 along with fatty foods, and the (adds peanuts)
peanut is one,...
35.3 provide us with a great deal of
energy. They give the cells energy. (talking from behind table)
energy to carry on their functions.

SCENE: 36 CLOSE-UP OF THE TRAY WITH FOOD;
TIME: 24 NARRATOR HOLDS OIL-STAINED PAPER ON TRAY

36.1 You know how to test starch by now,
by using iodine. And sugar of
course you can detect by its sweet
taste. You can detect... (close-up of tray with
food)
36.2 fatty foods by placing them on a
piece of shiny paper as I placed
these peanuts on this piece of shiny
paper earlier. Notice that it
stained or darkened them and
that's the way it appears to you.
Actually the fat has entered the
paper, causing the stain. (holds piece of paper on
tray; close-up shot con-
tinued)

SCENE: 37 NARRATOR TALKING FROM BEHIND TABLE; PUTS TRAY AWAY;
TIME: 76 HOLDS UP VITAMIN BOTTLE AND LEMON

37.1 There are other foods that we need. (puts away paper)

37.2	Minerals, very important to us, ...	(talking from behind table)
37.3	minerals such as iron, calcium, and iodine.	(puts tray away)
37.4	We even need traces of minerals such as phosphorous, which are found in the head of some matches. All these are important. Protein, which is necessary for repairing and building new cells, ...	(talking from behind table)
37.5	and vitamins. Now vitamins can be found in foods, and so on. And some vitamins are found, or better found, in some foods than in others. For ...	(picks up bottle)
37.6	example, ...	(puts away bottle)
37.7	vitamin C is found ...	(talking from behind table)
37.8	In citrus fruits, such as the lemon. Vitamins are very interesting and worth further ...	(takes up lemon, holds it, and puts it away)
37.9	Investigation. You may want to do this. Now if we eat the proper foods, have the proper diet, then we must do something with the energy that we have accumulated. And we do this in the form of exercise. Now you must be careful as you exercise. Exercise need not be strenuous. You should perhaps consult your doctor as to what exercise is best for you. These smoke jumpers must exercise a great deal. They must be in shape...	(talking from behind table)

SCENE: 38 FILM CLIP OF VARIOUS EXERCISES
 TIME: 20

38.1	we say. Watch as they go through their daily exercises, ...	("Jumping Jacks")
38.2	using the energy that they have taken in, ...	(close shot of neck rolling)
38.3	In food, building up their ...	(further shot of neck rolling)

38.4 systems. This ... (push-ups)
38.5 may well be too strenuous, this
type of exercise, too strenuous (jump and roll)
for you. You need not follow this
type of exercise.

SCENE: 39 NARRATOR TALKING FROM BEHIND TABLE
TIME: 10

39.1 Good health rules are sound,
reasonable rules for protecting (talking from behind table)
your systems.

SCENE: 40 CLOSE-UP OF ANIMATED CHART OF HUMAN BODY
TIME: 3

SCENE: 41 TRIANGLE FOR CALIBRATION PURPOSES
TIME: 10

SCENE: 42 WEST SIDE STORY SEQUENCE
TIME: 112

APPENDIX C

POST-TESTS

THE I KNOW IT BECAUSE TEST (IKB)

General Description

The IKB test was designed for the purpose of yielding separate scores for learning from audio and video portions of the educational television program selected as stimulus material. The following items were acknowledged prior to test construction:

- a. There would be little true independence of audio and video portions of the telelesson since the presentation was essentially an illustrated lecture.
- b. It would be difficult to test learning derived from the film since children, early in their lives, are usually taught health habits and some of the common cultural heritage concerning the germ theory of disease.
- c. What was truly unique about the film were the opportunities it provided for developing concepts of germs, red blood cells and white blood cells. Accordingly, the test would contain a considerable emphasis on these concepts as well as on certain formal properties of the germ theory of disease.

Administration and Scoring

The test was individually administered. This served to obviate readability problems, was consistent with the auditory stimulus used for the educational television film, and was requisite for the type of item designed in the test.

Items were in the form of true-false questions with the response requirement that the child not only state whether the item was true or false but that he document his response in as many ways as possible based upon the program. The information might have been derived either from the audio or video portions of the telelesson. Scoring was based not only upon the child's affirmation or denial of a statement, but upon his basis for documentation.

The testor recorded each child's responses and later placed them in categories of audio, video, or not-based-on-information-derived-from-the-film. The entire testing interview was recorded on tape by means of a concealed microphone. During the testing the administrator encouraged each child to respond on the basis of the film, to document as fully as he could, and to clarify the source (audio-video) of his information.

Instructions

At the beginning of the administration of the IKB test the testor stated the following: "I am going to read you some sentences about the television program you just saw. Some of the sentences are true and others are false. I want you to tell me whether each of the statements I read is true or false. Then I want you to tell me as many reasons as you can why you answered as you did. For example, if I were to say, the teacher's name was John Burns, what would you say?"

Items

1. Red blood cells have a hole in the middle.
2. Carbohydrates include potatoes, sugar, and peanuts.
3. A germ can be seen with the naked eye.
4. Red blood cells are alive.
5. Germs grow very fast.
6. There are eight red blood cells to every four white blood cells.
7. Red blood cells look like saucers.
8. Germs cause disease.
9. Red blood cells cannot move.
10. Germs are about the same thing as dirt.
11. Germs are mostly black in color.
12. When red blood cells are killed, they disappear without a trace.
13. Germs are like tiny worms.
14. White blood cells are hard to describe.
15. White blood cells attack and destroy germs.

VISUAL IDENTIFICATION TEST (VI)

General Description

The Visual Identification Test was designed to measure the ability to recall and correctly identify visual objects from the stimulus material. The test consisted of ten photographic plates from scenes in the telelesson each of which was covered by a series of five masks or overlays. In each mask an aperture was cut revealing a particular portion of the plate. The series of five masks were graded in that the first mask had the smallest aperture, with successive masks displaying increasingly larger apertures. Thus the subject was presented with a fragment or a cue of an object with the first mask and the entire object with the fifth mask. The entire plate was never revealed.

Administration and Scoring

The test was individually administered. Each subject was asked to fulfill two response requirements:

- a. to identify the object or objects represented by the cues and
- b. to report the cue used in identification.

Ten photographic plates, each with five masks, were mounted in a loose leaf notebook. The testor held the notebook and turned the pages at appropriate intervals. Scores were derived from the number of masks removed before identification. If a subject could identify an object when first presented with the plate covered by the first mask, he received a score of 5. If it was necessary to proceed through the masks to the fifth or last one for correct identification, the subject received a score of 1.

A score of 0 was given if the subject was unable to identify the object from the last mask.

Instructions

At the beginning of the administration the testor said, "I am going to show you some pictures of objects from the television lesson you just saw. These pictures are covered by a card with just a small part of the object showing through. I want you to tell me what you think the object is. If you cannot identify the object from the first card I will turn to another card which will show you more of the object." As each mask was presented the testor asked, "Now what do you think this is?"

After each object had been identified the testor would say, "How did you know what it was? What part of the object did you use to identify it?"

		<u>Items</u>
On Plate 1.	Scene 16.3	Fingernail file
On Plate 2.	Scene 34.4	"Carbohydrates"
On Plate 3.	Scene 32.	Red blood cell
On Plate 4.	Scene 19.	Several decayed teeth with one missing
On Plate 5.	Scene 19.	Petri dish with mold growth
On Plate 6.	Scene 22.	A bacterium
On Plate 7.	Scene 32.	White blood cell
On Plate 8.	Scene 16.3	Shampoo bottle
On Plate 9.	Scene 26.	Red and white blood cells
On Plate 10.	Scene 32.	Red blood cell

A representative plate from the Visual Identification Test is presented in Figure 27. The first mask revealed a small portion of the right petri dish while the fifth mask revealed the entire right dish.

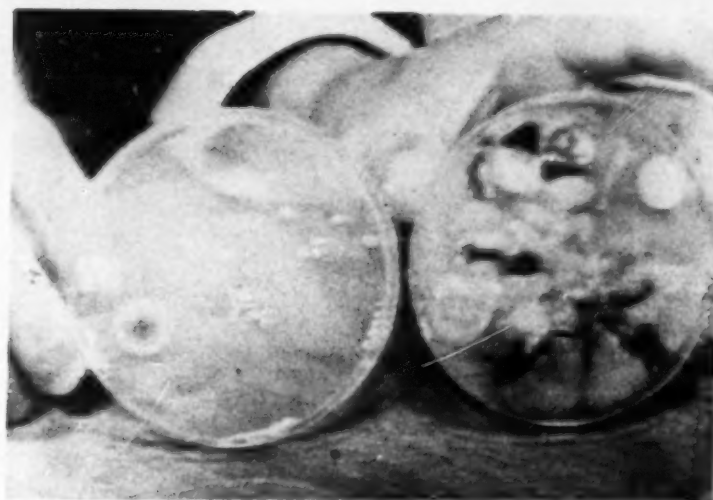


Figure 33: Plate Number 5 from the Visual Identification Test

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